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AGRICULTURAL ACTIVITY IN THE OHIO RIVER BASIN 80 & 2010: A PROJECTIVE STUDY

NATURAL RESOURCE ECONOMICS DIVISION

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AGRICULTURAL ACTIVITY IN THE OHIO RIVER BASIN, 1980 and 2010: A PROJECTIVE STUDY

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Natural Resource Economics Division

Economic Research Service

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PREFACE

A framework analysis of the water and related land resource problems in the Ohio River Basin is being made. The analysis is intended to include the combined interest of flood control, drainage, irrigation, navigation, water supply, water-quality control, recreation and other beneficial uses.

In order to provide broad and adequate coverage of these interests, the Ohio River Basin Coordinating Committee, which is composed of representatives of the several State and Federal agencies, including those of the Department of Agriculture, will be coordinating the studies in support of the framework analysis. The Corps of Engineers, Department of the Army, one of the participating agencies studying the Ohio Basin, has a leadership role for the framework analysis and supporting studies. One of the supporting studies is an economic base study with projections of economic activity that can be translated into water development needs. The A. D. Little Company has developed projections of the principal economic sectors of the Ohio Basin.

This report is the agricultural economic base study with projections which represent an in-depth study of one of the principal economic sectors in the Basin--agriculture. This analysis was performed by the Economic Research Service, U. S. Department of Agriculture and was

supported by funds transferred to the Economic Research Service from the Corps of Engineers, Department of the Army.

The analysis reported here is considered an adjunct and extension of the report prepared by the A. D. Little Company, "Projective Economic Study of the Ohio River Basin," published as Appendix B, Ohio River Basin Comprehensive Survey Report in August 1964. The analysis herein has implications concerning the output and employment data for agriculture and related sectors. Appendix B should be evaluated by participating agencies in light of the new information provided herein concerning agriculture. A statistical report was prepared by the Economic Research Service describing the present agricultural economy entitled "The Agricultural Economy of the Ohio River Basin" dated March 1964. Reference should be made to that report for current production patterns and trends.

The projections herein are for the years 1980 and 2010--dates agreed to at the outset of the study. Subsequently, decisions were made by the Coordinating Committee to develop information for 2000 and 2020. Only information for 1980 and 2010 are discussed here but interpolations of the information will be made for the USDA Appendix F. The user of the projection information should be cautioned that the results have a strict set of assumptions behind them. These assumptions are discussed throughout the report. The projections, after 1980 especially, should be considered as indicators of directional change rather than specific quantitative estimates of land use and development needs.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

SUMMARY

The Ohio River Basin covers parts of 11 states and comprises a significant portion of the Nation's agricultural production. The Basin is particularly important in production of feed grains and livestock. Moreover, agriculture plays a key role in the general economy of the Basin. This report provides information on the long-term outlook for output and employment in agriculture in the Basin. Such information is intended to be used in the comprehensive plan for development of the Basin's water resources. The projection model used in this study will be useful in developing estimates of the potential for the improved management of water resources, including drainage, flood control and irrigation.

The analysis began with a study of national production requirements for farm products in 1980 and 2010 based on expected population increases. An interregional analysis of the agricultural production expected from the Ohio Basin was based on historical trends and advice of commodity outlook specialists. Yields and production costs for the major crops were estimated for the projection years by ERS in cooperation with the Ohio Agricultural Experiment Station. Expected changes in agricultural technology were projected. A computer programming model was used to identify the patterns of land use that farmers in the Basin and its sub-areas would likely follow in producing the Basin's

crops and pasture under continued efficient farm resource organization. Allowance was made for reduction in the agricultural land resource base by urban developments expected to accompany the projected increases in population.

Livestock feeding efficiencies were projected to improve by 10 percent from current levels to 1980, with similar increases to 2010. Production of all classes of livestock and livestock products are expected to rise in both 1980 and 2010.

The results of the projection procedures indicate that production requirements in 1980 can be met from a smaller acreage of cropland and pasture land than is currently in production. About 8.5 million acres of such land are now idle, and in 1980, idle land is projected to increase to about 13 million. By 2010, however, practically all the idle land will be back in production, with only about 1.6 million acres idle.

The projections of agricultural activity have implications for water resource development. A scarcity of land resources is projected for the long run, making improvements of the resource base (e.g., drainage, irrigation, or flood protection) look more attractive. Considerable water resource development for agricultural purposes is expected to be economic by 1980 and may be imperative after that date, especially if the Nation's agricultural production requirements increase as expected.

Current studies of irrigation and drainage potential among sub-basins and livestock production associated with the cropping patterns

found in this analysis will be reported at a later date and distributed as addenda to this document.

Estimates of farm production and trends in farm numbers and sizes provided a basis for estimating agricultural employment and farm population. Labor requirements for production were based on projections of output per man-hour and number of man-hours worked per year developed by the Water Resources Council. Labor requirements, and hence, farm employment are expected to decrease at least through 2010, despite significant increases in farm production. Farm population also will decline as a result of lower farm employment and smaller size of farm families.

AGRICULTURAL ACTIVITY IN THE OHIO RIVER BASIN, 1980 and 2010: A PROJECTIVE STUDY 1/

INTRODUCTION

This report summarizes the results of a study on the long-term agricultural outlook of the Ohio River Basin. The kinds and quantities of agricultural products likely to be produced in the Basin are projected. In addition, rural farm population numbers and rural farm employment are estimated. The purpose of this report is to provide supplementary information to be utilized in the comprehensive plan for the development of the water resources of the Ohio River Basin. The plan is intended to include the combined interest of flood control, drainage, navigation, irrigation, water supply, water-quality control, recreation and other beneficial uses.

The comprehensive plan for the development and use of an area's water resources requires information of many types. Among these are

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1/ This report was prepared by Melvin L. Cotner, Leader, North Central Resource Group, Natural Resource Economics Division, Economic Research Service, USDA. Principal contributions in the analysis of data were made by W. H. Heneberry, John Fritschen, Vernon McKee, Dallas Lea, John Hostetler, Ruane Dunlap and Waldon Miller, all from ERS. The assistance of W. A. Green, Deputy Director of the Natural Resource Economics Division, in staffing and funding the study is acknowledged. Special thanks is extended to Pat Durst and Marie Quance for their reproduction of the report. Appreciation also is extended to those members of the Soil Conservation Service, Forest Service and the Corps of Engineers who reviewed an earlier draft.

studies of population concentrations and the requirements for domestic water and water-quality control measures. Another concerns the concentration of industry with high water requirements of contributions to pollution. Water may not be available in sufficient quantities and qualities to provide for all of the beneficial uses. Resource development may be required to provide for water supply and quality in these instances. Even then, all of the uses may not be satisfied. Individual studies of each beneficial use are necessary to determine the gains or losses incurred if a particular use is satisfied or restrained.

METHODOLOGY

The future agricultural use of the land and water resource in the Ohio River Basin depends importantly on the kinds of food and fibre products consumers will demand in the future. Ohio River Basin farmers serve both national and foreign markets. The amount and kind of agricultural production forthcoming from the Basin also depends heavily upon the future productivity of the agricultural land base. Ohio River Basin farmers must compete with other basins and regions in the production of agricultural commodities. Several nonagricultural uses of land, such as urban, recreation and highway development also have a bearing on land available for agriculture. The general methodological approach used represents an attempt to take these major forces into account.

Projection Technique

The principal tool for projecting future land use is the economic budgeting model. Simply, the economic budgeting model simulates farmers' decisions with respect to land use when confronted with an expected consumer demand for food and fibre. The logic of the economic budgeting model is that resource owners tend to organize these resources to maximize profits and minimize costs of production. The model is modified to reflect decisions of resource owners that are not wholly

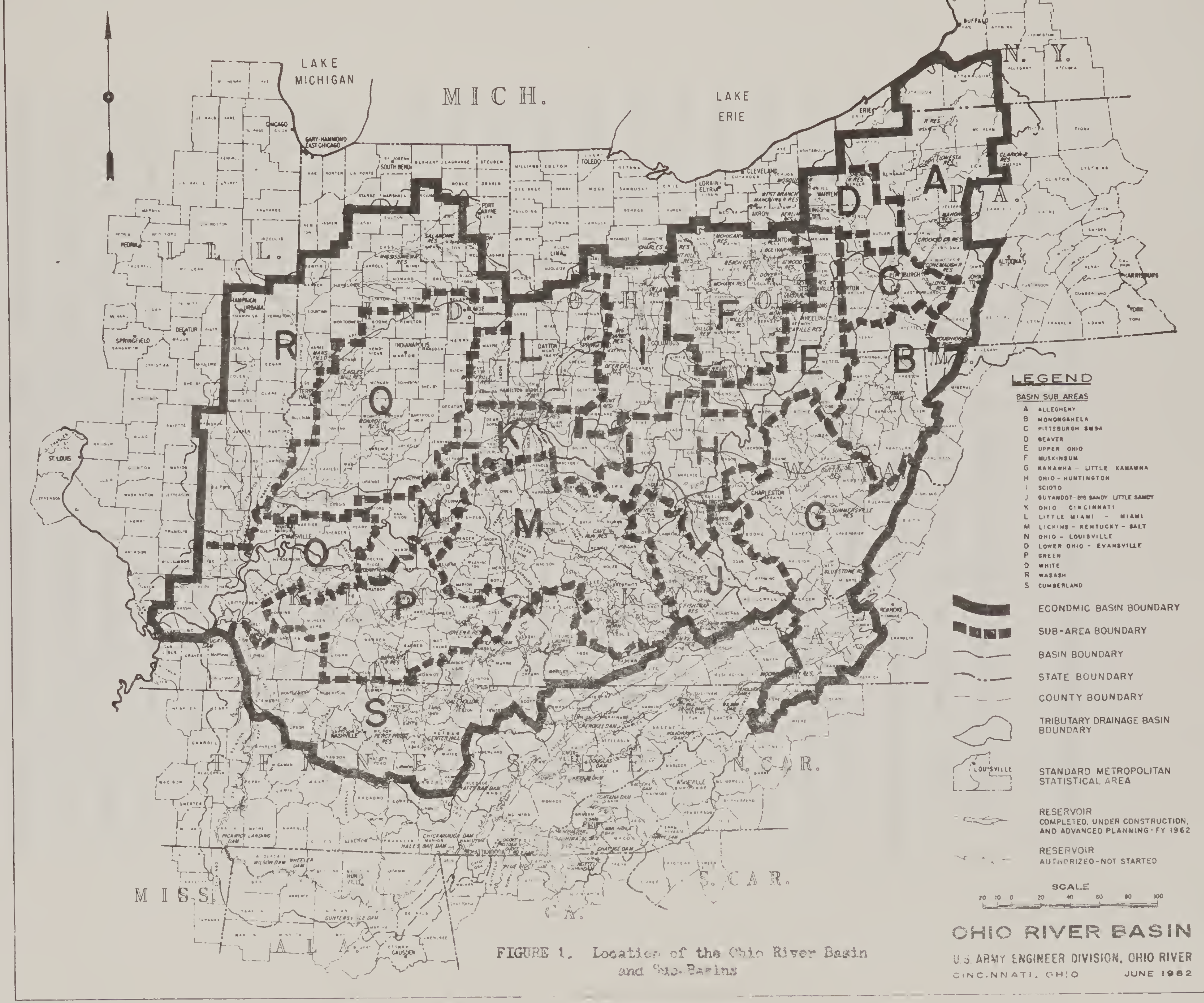

FIGURE 1. Location of the Ohio River Basin and Sub-Basins

profit oriented or are made because of certain unavoidable constraints in the use of their resources.

To utilize the model, the demand or requirements for food and fibre must be known for the region or basin to be analyzed. This includes domestic and foreign demands as well as livestock requirements for feed grains. The acreage of the various kinds and qualities of soils in the agricultural land base must be available. For each soil group, projected yield for the potential crops and the costs of production must be developed. The projected yields must reflect the expected adoption of existing and new technology. Production costs must reflect the technological changes in production techniques and account for possible substitution of one input for another. The operation of the budgeting model involves the selection of those cropping patterns, among all of the alternative cropping possibilities, that will maximize economic gain within the constraints likely to confront farmers.

In the application of these procedures several analytical techniques are used--many of which require the use of a computer. "Linear programming" is the computer counterpart of the economic budgeting model. The economic budgeting model can be set up two ways on the computer. One is to maximize profits from a given set of resources with the assumption that there is unlimited demand for food and fibre. The second is to start with a given demand or requirement for food and fibre and budget the most profitable and efficient way of producing this product. The second approach is used and is called the

"minimum cost" economic budgeting model. By starting with a given level of demand for food and fibre, we can be assured that production in the Nation, region and sub-basins will be consistent with the national demand. In using the minimum-cost approach in projecting land use, it is necessary to determine the likely effective demand for food and fibre on a national and regional basis.

Details of this methodological approach will be presented in subsequent sections of this report.

General Assumptions

The general economy of the United States is assumed to prosper during the period to be projected. There is expected to be "a high level of national employment and activity, no major depressions or wars, and a continuation of the current relative needs of the civilian economy and the national defense." 1/ Disposable income is expected to increase with continued strong demand for agricultural products. Increased food consumption per person is not expected but changes in the combination of food items demanded are expected. Population increases will provide the major change in total food and fibre requirements. No major shortages of production inputs are assumed.

The population assumptions for the Nation and Basin area are the same as those used in the economic base study published as Appendix

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1/ See the report, "Projective Economic Study of the Ohio River Basin," Ohio River Basin Comprehensive Survey, A. D. Little Company, August 1964, p. 127.

B. 1/ (Table 1). These are the series III Census Bureau population assumptions.

Table 1. Current and Projected Population, U. S. and Ohio River Basin

	Total Population			Urban Population		
	1960	1980	2010	1960	1980	2010
	Millions of Persons					
United States	178.5	244.8	378.2	124.7	188.5	316.2
Ohio River Basin	19.0	23.1	31.6	11.0	14.8	23.0

Projections of economic activity are contingent on the attendant assumptions. If the assumptions hold valid, the results of this analysis should be good indicators of the likely production patterns.

Plan of Report

The plan for this report is to first describe the objective and scope of the study, then describe the major physical characteristics and land-use trends that are relevant to the agricultural economy of the Ohio River Basin. Following this section, the general procedure and methodological approach to the agricultural economic base study will be presented. Subsequent chapters will present results from the major steps in the analysis. Assumptions and limitations will be discussed in each chapter where relevant.

Specific Objective

The primary objective of this study is to identify the pattern of land use that farmers in the Basin likely will use to satisfy future agricultural production requirements. A second objective is to develop a projection model that will permit analyses of the effect of agricultural water resource management measures. Other objectives include the development of rural farm population and employment estimates for the sub-basins in the study area.

CHARACTERISTICS OF THE BASIN

The Ohio River Basin is described in other reports and appendices in the comprehensive study. Only those characteristics pertinent to the agricultural development of the Basin are discussed here. The sub-basin definition used in this study is identical with that used in Appendix B of the Ohio Basin Comprehensive Survey Report except that Cattaraugus and Chautauqua counties of New York State are added to the Allegheny Sub-basin. For purposes of the economic base studies, the Basin and sub-basins have been identified in terms of counties (See Figure 1).

General Climate

The Basin lies wholly within the humid eastern United States and is considered to have a climatological water surplus. The weather systems usually pass from west to east; however, the area also receives masses of cold polar air from the north and warm tropical air from the south. Either type might move in at any time of the year with the accompanying affects of chilling or warming. Spring and summer thunderstorms with intense rains of short duration are common. The variance in temperature and precipitation from year to year and among sub-areas of the Basin has a significant affect on agricultural production.

Summer temperatures vary from the northeast to the southwest part of the Basin and are associated with changes in elevation. The average

July temperature is 75° F. Winters are fairly cold with an annual average of several days of sub-zero weather. Minimum recorded temperatures have been near 30° below zero. The annual variation in temperature for nine locations spaced throughout the Basin is shown in Figure 2. Overall, the Ohio Basin exhibits a degree of homogeneity in climate, however, extremes are common with very hot and sub-zero temperatures sometimes occurring in the same year. Also, severe droughts and floods have occurred in the same 12-month period, having a diverse influence on agricultural production.

The future need for and value of additional water in agriculture is of primary interest as one of the many alternative uses to be appraised. Rural farm population numbers can be translated into domestic water requirements, livestock numbers implicit in the cropping and livestock production patterns in the Basin can be translated into livestock water requirements. Studies are underway to determine the need for irrigation and drainage in the Basin.

Frost Periods

Last killing frosts occur on the average from April 10 in the southern-most part of the Cumberland Basin in Tennessee to May 30 in the headwaters of the Allegheny River--the most northerly part. Conversely, first frosts occur on the average from September 30 in the Allegheny Basin to October 20 in the Cumberland Basin. Killing frost has occurred as late as May 1 at Clarksville, Tennessee, and June 12 at Franklin, Pennsylvania, and as early as August 13 at Franklin and October 2 at Clarksville. Late killing frosts constitute a

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1/ Ibid., p. 6.

particular hazard to the production of row crops and to early blooming fruit trees in the Ohio Basin. The average growing season varies from 120 days in the northeast part of the Basin to 200 days in the southern part (Figure 3). The longer growing season and warmer temperature allows production of cotton and tobacco in the southern portion of the Basin.

Precipitation

Annual precipitation including snowfall varies considerably as to location and also from year to year (Figures 4 and 5). Total precipitation increases from north to south with the average annual for the entire Basin being 44.8 inches. It varies from 36 inches along the northern divide to 52 inches in the southwest section on to 56 inches in the southeast section. It may reach as high as 80 inches in the isolated points of higher elevation in the Allegheny Mountains.

Greatest average monthly precipitation occurs in June or July and minimum in October with some minor modifications due to elevation and location (Figure 2). Precipitation is generally sufficient for agricultural uses and for domestic water supplies. However, due to poor rainfall distribution at intervals, reduction of soil moisture to the wilting point of vegetation does occur occasionally. Major droughts also cause domestic water shortages, primarily in rural areas.

HIGHEST, MEAN, AND LOWEST MONTHLY AVERAGE TEMPERATURE AND AVERAGE PRECIPITATION FOR SELECTED OHIO RIVER BASIN STATIONS

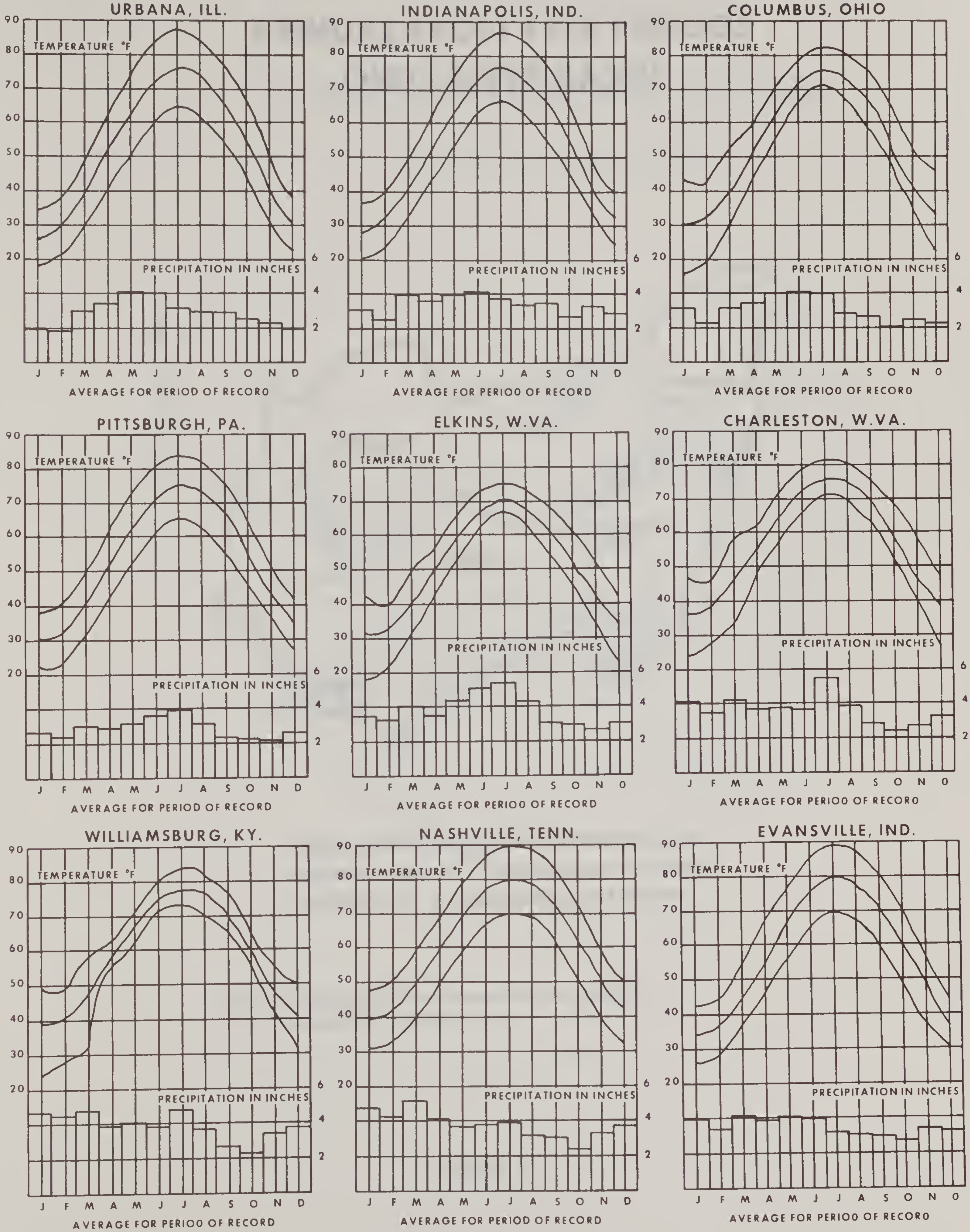

FIGURE 2

ANNUAL FROST FREE PERIODS
OHIO RIVER BASIN

MEAN LENGTH OF FREEZE-FREE PERIOD (DAYS) BETWEEN LAST 32° F. TEMPERATURE IN SPRING AND FIRST 32° F. TEMPERATURE IN AUTUMN.

SOURCE: Climatological Maps from National Atlas of United States
Published by U. S. Weather Bureau

FIGURE 3

AVERAGE ANNUAL PRECIPITATION
OHIO RIVER BASIN

ANNUAL PRECIPITATION (INCHES).

SOURCE: Climatological Maps from National Atlas of United States
Published by U. S. Weather Bureau

FIGURE 4

Droughts are usually spotty or local in nature and crops are seldom a total loss but economic loss due to reduction in agricultural yield is common. The peak supplementary irrigation demand normally occurs from July 1 to August 15. The frequency of major widespread droughts in the Ohio Basin is once every 6 to 7 years.

Floods

The occurrence of floods in the Ohio Basin varies from one part to another and seldom cover the entire Basin during the same climatic period. However, widespread flooding due to frontal-type storms with prolonged rainfall have occurred. Historically, in the Ohio Basin this type of flood has usually occurred during the winter months--before the growing season. Nevertheless, they inundate large acreages of farmland on the main stem and larger tributaries, causing considerable agricultural damage.

Local thunderstorms with heavy rains of short duration usually occur during the spring and summer. These may cause flash flooding on small streams and result in damage to crops, pasture, and other agricultural property. The Ohio Basin averages 30 to 50 days annually with thunderstorms, only a few being severe.

Snowfalls may be heavy but are usually followed by thawing periods and there is no large-scale melting in the spring of a seasonally accumulated snowpack. However, heavy rains falling on snow have caused floods in the Basin.

Pattern of Drainage

The streams in the Ohio Basin with the exception of those in the glaciated areas are essentially remnants of a stream pattern formed on an ancestral eroded plain, which sloped to the north and west. The present incised stream pattern in most areas still exhibits the general meandering of these former mature streams although slopes are steeper.

The main stem of the Ohio is formed by the junction of the Allegheny and Monongahela rivers at Pittsburgh and then flows in a general southwesterly direction for 981 miles to Cairo, Illinois, where it empties into the Mississippi River. Major tributaries entering from the north are the Beaver, Muskingum, Hocking, Scioto, Little Miami, Miami, and Wabash rivers. The larger streams entering from the more mountainous area on the south side are the Little Kanawha, Kanawha, Guyandotte, Twelvepole, Big Sandy, Little Sandy, Licking, Kentucky, Salt, Green, Cumberland and Tennessee rivers.

The drainage area at Pittsburgh is 19,000 square miles. At the mouth of the Kanawha River, 266 miles downstream, the drainage area is 52,760 square miles including the 12,200 square miles in the Kanawha Basin. At Cincinnati the drainage area is 76,580 square miles including the 3,670 square miles in the Licking River Basin (Ky.) which joins the Ohio at that point. The drainage area at Louisville is 91,170 square miles and at Evansville, upstream of the Wabash, it is 107,000 square miles. The Wabash contributes an additional 33,100 square miles, the Cumberland--17,920 and the

Tennessee--40,190, which together with the smaller tributaries and direct drainage to the Ohio results in the 203,940 square mile drainage area at the mouth. The Tennessee River Basin, however, is omitted from this report.

Streams in the Ohio Basin vary from very steep mountain streams with cascades and rapids to very sluggish meandering well-graded slough and marsh-like areas. In general, the streams are considerably steeper in the headwaters and become relatively flat near the mouth. However, glaciation north of the main stem created variations in this condition in some locations. In the glaciated areas of Indiana, remnants of marshes and bogs have resulted in the upstream areas being relatively flat and sluggish and the intermediate reach being the steepest.

Geology

The geology of the Basin consists of three broad physiographic regions. The eastern part of the Basin lies on the Allegheny and Cumberland Plateau. The bedrock, of the carboniferous age, is generally level but locally is strongly folded and faulted such as the Allegheny and Cumberland Mountain ranges. The topography is rugged. Valleys are narrow; consequently, large areas of flat tillable land do not exist. Opportunities to combine tracts of land into larger farm units are limited.

The central and lower part of the Ohio Basin lies within the Interior Low Plateau (also called Interior Lowlands). The bedrock

is largely Palezoic in age. The bedrock is generally level to gently dipping. The attitude of the bedrock is controlled broadly by three major regional bedrock structures: (1) The Illinois - western Kentucky Basin, (2) The Cincinnati Arch, and (3) The Nashville Dome. The soils are chiefly made up of limestones, supporting areas such as the Bluegrass region of Kentucky. While the region is primarily farmland, the lands are not as productive as other areas in the Midwest.

The Till Plains north of the Ohio River has bedrock similar to Interior Low Plateau. But this area has been covered with glaciers during the Pleistocene age leaving deposits of unconsolidated material called drift or till. The drift ranges in thickness from a few feet to several hundred feet. The level to rolling glaciated areas in this region represent some of the most productive land in the region and nation.[1/]

More detail on topography and soils is presented in the following section on Land Resource Areas.

Land Resource Areas

Land Resource Areas are large, broad regions with general similarity of climate, topography, geology, soil, vegetation, and agricultural development. The Ohio River Basin contains various parts of 16 Land Resource Areas, with a few lying completely within

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[1/] For a discussion of the geology of the area, see Lobeck, A. K., Geomorphology, McGraw Hill Book Company, Inc., New York, pp. 526-27.

the Basin (Figure 6). Contrasts between Land Resource Areas are usually rather sharp and in some instances very abrupt. Furthermore, it might be pointed out that there is virtually no correlation between Land Resource Areas and sub-basins. Their boundary lines usually overlap.

Significant characteristics pertaining to size, topography, soils, land use and major crops in each Land Resource Area are summarized in Table 2. For purposes of the analysis, Land Resource Areas with insignificant acreages in the Basin have been combined with adjacent LRA's.

Soils

The sub-basins in the northwest part of the Ohio region have a slightly higher concentration of more productive soils (Figures 7 and 8). The Wabash and White sub-basins especially are composed mainly of land capability Class I, II, III and IV soils. Land capability classes refer to the management requirements to maintain and use a particular soil. Limitations in use become progressively greater from Class I to Class VIII. Class I through IV soils are the more productive soils with fewer conservation problems. Class V through VIII soils usually are shallow, unproductive soils with steep slopes. Lands used for crop production predominantly are in the Class I through IV class. Pasture lands frequently contain large portions of Class V through VIII soils. However, since considerable pastureland is in the more productive class that could be cropped, the potential

Table 2. Significant Characteristics of Land Resource Areas, Agricultural Land, Ohio River Basin

Land Resource Area	Approximate Area	Average Annual Rainfall	Relief and Surface Drainage	Soil	Native Vegetation	Land Use and Major Crops
	000 Acres	Inches				
108 Illinois & Iowa, Deep Loess and Drift	1,574.9	30--35	Rolling to hilly topography with broad, level to undulating uplands. Local relief ranges from a few feet to 100 or 200 feet. Majority of the area has poor drainage, remainder is adequate.	Prairie soils from loess deposits dominate the area. Flats and depressions also have dark, poorly drained soils. Steep slopes have light colored soils with clay accumulation in sub-soil.	Largely prairie grass such as Big and Little Bluestem, prairie count grasses, switch grass and sand love-grass.	Nearly all in farms with about three-fourths in cropland. Corn, soybeans, other feed grains and wheat are main cash crops. Also, hay, pasture and livestock.
110 Northern Illinois & Indiana Till Plain	1,203.0	30--35	Nearly level to sloping glaciated plain. Streams have cut only shallow valleys over much of area. Moderately good natural surface drainage. Poor drainage in spots.	Prairie soils on calcareous glacial material are dominant. Dark, poorly drained soil on flats and depressions. Small tracts of light colored soils with clay accumulation in sub-soil in the north.	Tall prairie grass, mainly Bluestem. Some wet sites had Elm, Ash, Soft Maple, Tamarack, Cherry, Aspen with under story of grasses, weeds, and sedges.	Mainly in farms, but Greater Chicago takes up about one-fifth of the area. Corn, soybeans, and other feed grains are main cash crops. Hay and dairying are also important.
111 Indiana & Ohio Till Plain	15,146.5	35--40	A gently sloping glaciated plain interrupted in places by ridges and knolls. Large streams are few and commonly have narrow, shallow valleys. Surface drainage generally good near streams, generally poor away from streams.	Light colored soils on glaciated material with clay accumulation in subsoil are dominant. Southern part also has wind-blown silts. Flats and depressions have dark, poorly drained soils.	Mixed hardwood forest, mainly oak, hickory, and tulip poplar.	More than 90 percent in farms and about four-fifths in cropland. Corn, other feed grains, soybeans, and hay are main crops. Dairying near cities. Also truck and canning crops.
114 Southern Illinois & Indiana Thin Loess & Till Plain	5,316.1	35--45	Glaciated plain divided by ridges with steep slopes. Most of the ridge tops are narrow, some are broad. Surface drainage is generally good, but is rather poor on flat ridge tops.	Light colored soils developed in thin loess and leached glacial till. Clay accumulation in sub-soil. Some fragipans. Alluvial soils in flood plains. Strong acidity throughout southern part.	Mixed hardwood forest, mainly oak, hickory and tulip poplar.	Nearly all in farms but only about one-half in cropland. Corn, soybeans, other feed grains and hay for dairy and other livestock are main crops. About one-fifth in forest, most of remaining farmland in pasture.
115 Central Mississippi Valley Wooded Slopes	4,153.3	35--45	Glaciated plain crosses by steep ridges. Small streams have narrow valleys and relatively steep gradients. Major rivers have broad, fairly level flood plains. Most of the drainage is good, but areas along the streams are flat with slow runoff.	Light colored soils over glaciated material and bedrock are dominant. Ridge tops in southern part have fragipans. About one-tenth of the area is in flood plain consisting of alluvium and dark, poorly drained soils. Generally strong acidity.	Mixed hardwood forest, mainly oak, hickory and tulip poplar.	Nearly all in farms with about two-fifths in cropland. Corn, other feed grains, hay, pasture and livestock. Peach and apple orchards are important. About one-third in forest.

Table 2. Significant Characteristics of Land Resource Areas, Agricultural Land, Ohio River Basin (CONT.)

Land Resource Area	Approximate Area	Average Annual Rainfall	Relief and Surface Drainage	Soil	Native Vegetation	Land Use and Major Crops
	000 Acres	Inches				
120 Kentucky & Indiana Sandstone & Shale Hills & Valleys	7,150.1	40--48	Gently rolling to hilly sandstone and shale plateau with a loess cap. Surface drainage is good except in flat areas of plateaus and alluvial bottoms.	Light colored soils with a thin to moderately thick loess mantle over residuum from acid sandstones and shales are dominant on the smooth flats and low hills. Some alluvial flood plains. Generally strong acidity.	Mixed hardwood forest, mainly oak, hickory and tulip poplar.	Nearly all in farms with about 40 percent in cropland and 50 percent in forest. About 5 percent urban. Considerable strip mining. Corn, soybeans, other feed grains and hay in support of dairying and other livestock. Some tobacco and apple and peach orchards.
121 Kentucky Bluegrass	6,171.6	About 45	Undulating to rolling central limestone plain surrounded by shale and limestone hills with narrow ridge tops and steep sides. Relief varies from a few feet to 500 feet. Natural surface drainage for the most part is good to excessive.	Light colored soils on rolling to hilly uplands underlain by calcareous rocks are dominant. Also reddish-yellow soils on deeply weathered phosphatic limestone. Most soils are acid except the steep limestone hills.	Mixed hardwood forest, mainly oak, hickory, and tulip poplar.	Most of the land is in farms but slightly less than one-third is cropland. Corn, other feed grains and hay in support of livestock are the principal crops. Tobacco is important cash crop.
122 Highland Rim & Pennyroyal	9,451.1	45--54	Plateau divided by ridges, especially in the west. Steep slopes and narrow valleys. Most of the surface drainage is good except in the flat to undulating areas where it is poor.	Light colored soils with clayey sub-soil are dominant throughout the area. These soils are developed mainly in this loess and residuum from limestone. Some alluvial flood plain soils. Medium to strong acidity.	Mixed hardwood forest of oak, beech, red cedar, tulip poplar.	Mainly in farms with about 40 percent in cropland. Corn, other feed grains, and hay in support of livestock. About one-sixth of the area in pasture, one-third in forest.
123 Nashville Basin	1,909.8	About 50	Gently rolling to hilly limestone plain in central part with relief from a few tens of feet to about 100 feet. Outer margins have steep ridges with relief of several hundred feet. Mostly good surface drainage.	Reddish yellow soils from limestone are extensive. Also large areas of limestone rock land. Alluvial soils in flood plain. Acidity present except in limestone areas.	Mixed hardwood forest of oak, beech, red cedar, tulip poplar and hickory.	Nearly all in farms with about 40 percent in cropland. Grain and hay in support of beef and dairy cattle are main crops. About one-third of area in pasture, one-fourth in forest.
124 Western Allegheny Plateau	5,035.4	40--45	Plateau divided by rolling to steep ridges. Level valley floors. Local relief is from 100 to several hundred feet. Most of the surface drainage is rapid.	Light colored soils with accumulation of clay sub-soils are dominant. Soils are moderately deep to shallow overlapping shale and sandstone. Natural fertility generally low. Most soils strongly acid.	Mixed hardwood forest, mainly oak, hickory and tulip poplar.	Mostly in farms but about one-fourth in other uses. Main crops are hay and feed grains for livestock. Fruit and vegetable growing are important locally. About one-fifth of area in pasture, two-fifths in forest.

Table [illegible]. Significant Characteristics of Land Resource Areas, Agricultural Land, Ohio River Basin (Cont.)

Land Resource Area	Approximate Area	Average Annual Rainfall	Relief and Surface Drainage	Soil	Native Vegetation	Land Use and Major Crops
	000 Acres	Inches				
125 Cumberland Plateau & Mountains	12,743.7	42--56	Sandstone and shale plateau divided by steep-sloped ridges separated by narrow level valleys. Local relief is mostly from a few hundred feet to over 1,000 feet. Surface drainage is largely good to excessive.	Brown acid soils are the principal groups on hilly and steep slopes. Many small areas of rough stony land and rock outcrop. Alluvial soils on flood plains and valley floors. Generally low fertility and strong acidity.	Mixed hardwood forest with oak predominantly.	About 80 percent in forest, mainly private ownership. Coal mining is the major industry. Only about five percent of the area in cropland, slightly less in pasture. Main crops are tobacco, corn and truck crops.
126 Central Allegheny Plateau	11,778.6	35--45	Plateau that is sharply divided by numerous ridges with steep slopes and narrow level valleys. Local relief is from a few hundred to several hundred feet. Surface drainage is largely good to excessive.	Light colored soils derived from interbedded sandstones and shales are dominant. Clay sub-soil. Terrace soil along the Ohio River. Also alluvial soils in the Ohio River flood plain. Strong acidity except in cases of local limestone.	Mixed hardwood forest, mainly of maple, beech and some oak.	About three-fourths in forests, mainly small private ownerships. Lumbering, wood use industries, and coal mining are main industries. About one-tenth in cropland, mainly hay and other feed crops for dairy cattle.
127 Eastern Allegheny Plateau & Mountains	6,341.9	40--60	Deeply divided plateau terminating in a high escarpment on the east. Steep slopes are dominant but level to gently rolling plateau remnants appear in the north. Local relief is mainly a few hundred to several hundred feet. Drainage is mostly good to excessive.	Brown acid soils from gray sandstone and red shales are dominant on the extensive steep slopes. Alluvial and dark, poorly drained soils in the flood plains of larger streams. Strong acidity in general.	Mixed hardwood forest, mainly of maple, beech and some oak.	About three-fourths in forests, mainly small private ownerships. Lumbering, wood use industries and coal mining are main industries. About one-tenth in cropland, mainly hay and other feed crops for dairy cattle.
128 Southern Appalachian Ridges and Valleys	2,271.2	35--55 Increasing from north to south.	Northeast, southwest trending valleys separated by steep ridges or mountains. Valleys are undulating to strongly rolling or hilly. Most surface drainage is rapid.	Light colored soils with clay sub-soil. Also considerable areas of limestone. Steep sloping ridges [illegible]	Mixed hardwood forest, mainly oak, hickory and tulip poplar.	About one-half of the area is forest, one-sixth in cropland, and one-sixth in pasture. Feed and forage for livestock. Tobacco is main cash crop.

Table 2. Significant Characteristics of Land Resource Areas, Agricultural Land, Ohio River Basin (CONT.)

Land Resource Area	Approximate Area	Average Annual Rainfall	Relief and Surface Drainage	Soil	Native Vegetation	Land Use and Major Crops
	000 Acres	Inches				
139 Eastern Ohio Till Plain	1,462.3	35--40	Gently to strongly rolling glaciated plateau. Stream valleys are narrow and shallow. Majority of surface drainage slow. Small percentage rapid, remainder moderately good.	Glacial drift with slow permeability in general due to fragipans or clay sub-soil. Some areas of gravelly and sandy ridges and potholes. Medium fertility, medium to strong acidity in general.	Mixed hardwood forest, mainly oak, sugar, maple and beech.	Mostly farms. Highly intensive dairy area. Principal crops are corn, small grains and hay. Considerable acreage of truck crops. About one-fifth of area in forest.
140 Glaciated Allegheny Plateau and Catskill Mountains	2,065.7	30--40	Plateau divided by steep ridges with broad, nearly level to moderately sloping tops. Narrow valleys with smooth floors. Majority of surface drainage rather poor, some moderately good.	Moderately deep to deep, somewhat stony, medium-textured, acid soils with fragipans are dominant. Shallower and more stony soils on steeper slopes. Deep, loamy, well-drained soils in valleys.	Mixed hardwood forest, mainly beech, birch and maple.	Mostly in farms but large areas are forested. Much of Catskills used mainly for recreation. Hay, pasture, some grain and dairying. Considerable quantities of commercial poultry, potatoes, fruit, and vegetables.

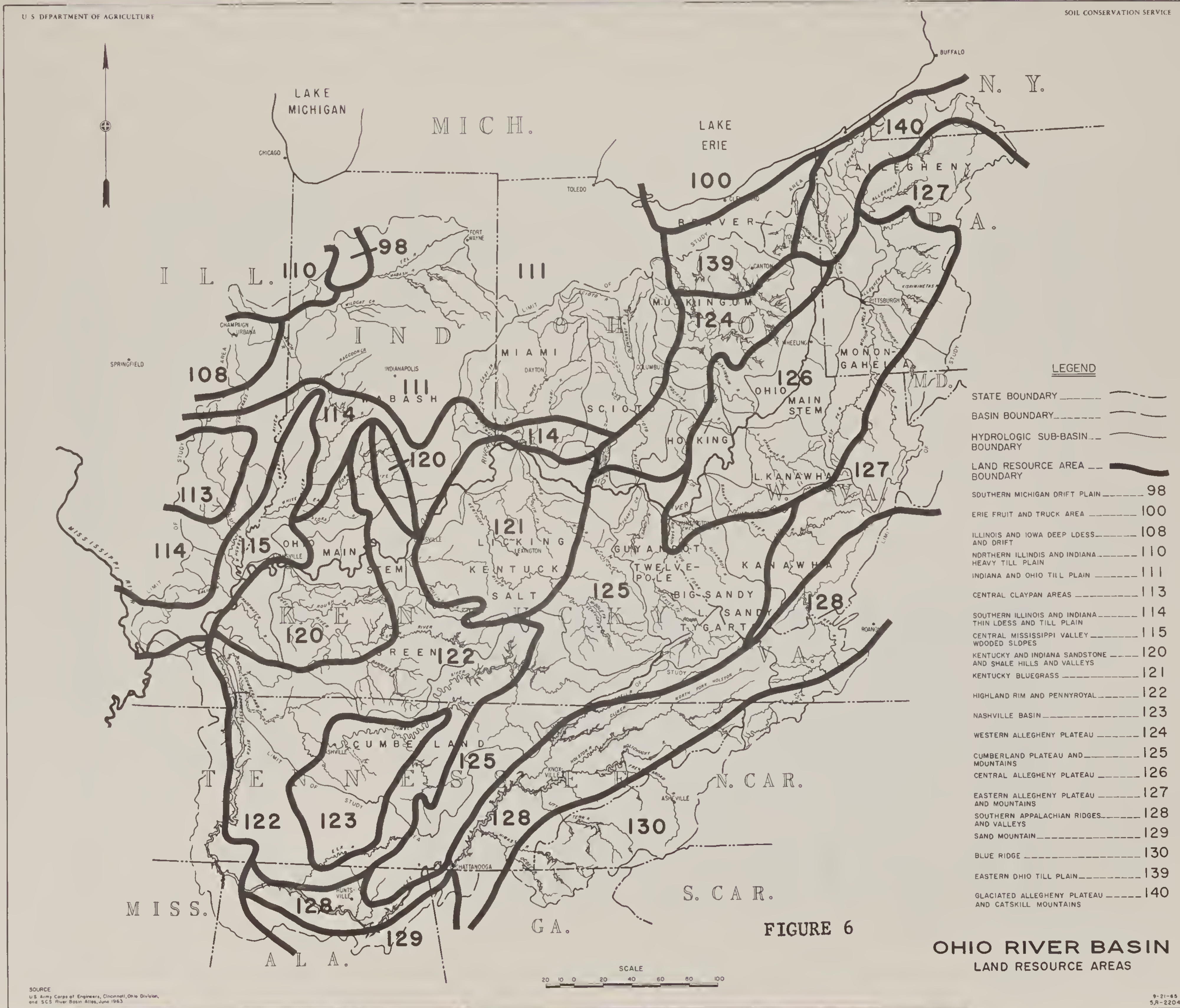
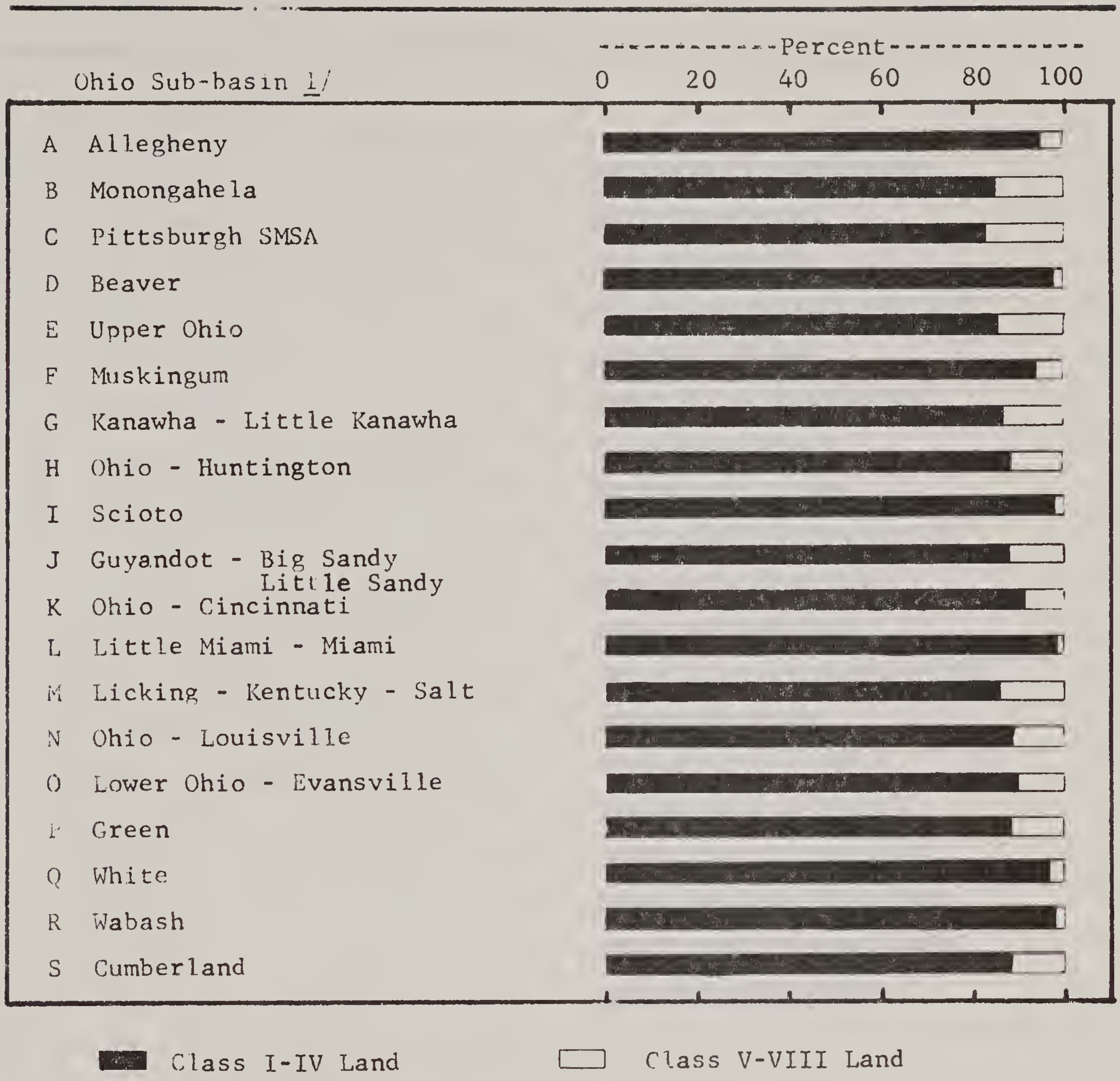


FIGURE 6

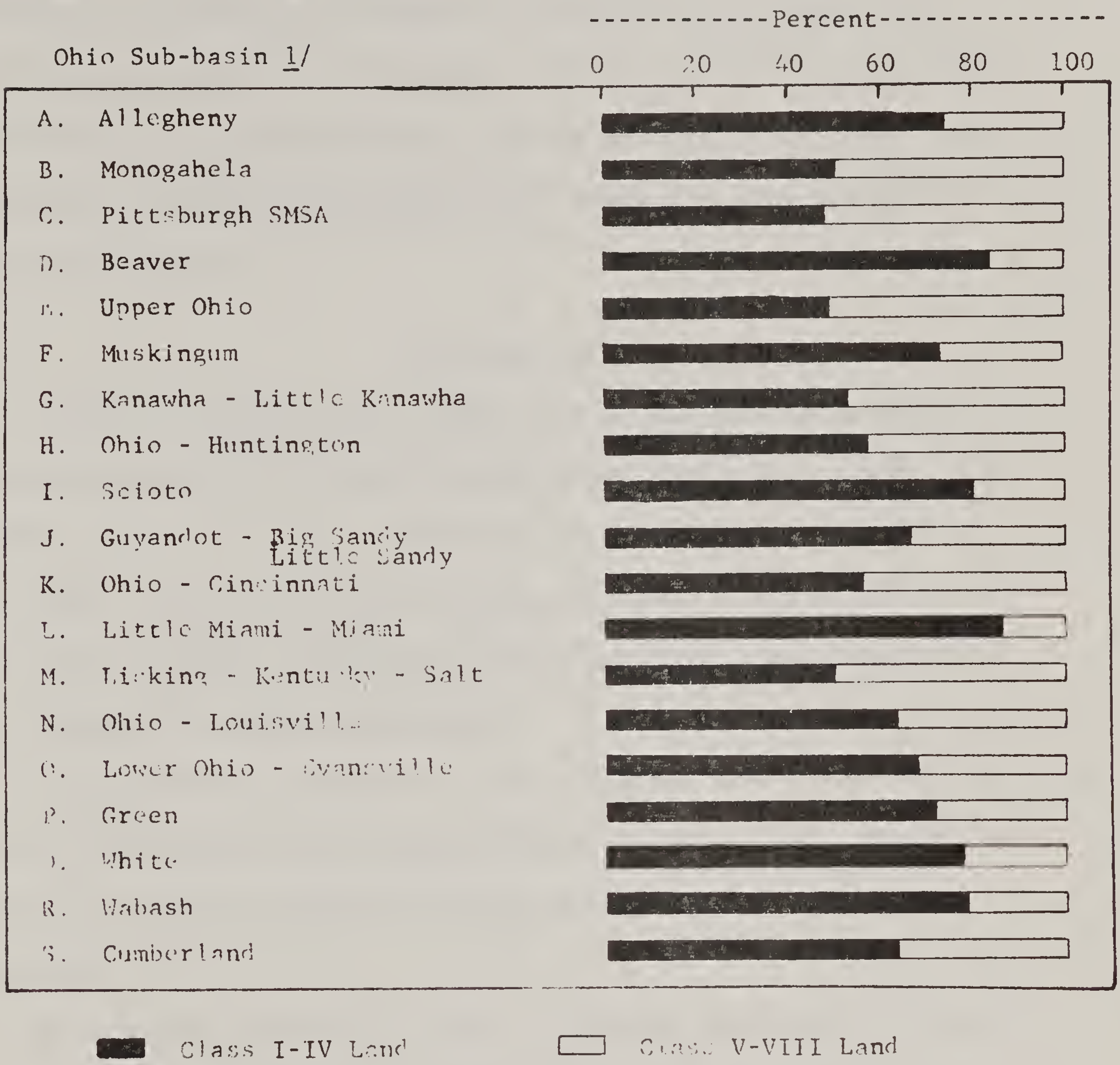
OHIO RIVER BASIN
LAND RESOURCE AREAS



1/ Sub-basin definition identical with that used in Appendix B of the Ohio River Basin Comprehensive Survey report except that Cattaraugus and Chautaugus counties of New York State are added to the Allegheny Sub-basin.

Source: National Inventory of Conservation Needs, USDA

FIGURE 7. DISTRIBUTION OF LANDS USED AS CROPLAND BY MAJOR SOIL CLASS AND SUB-BASIN, OHIO RIVER BASIN, 1958



1/ Sub-basin definition identical with that used in Appendix B of the Ohio River Basin Comprehensive Survey report except that Cattaraugus and Chautaugua counties of New York State are added to the Allegheny Sub-basin.

Source: National Inventory of Conservation Needs, USDA

FIGURE 8. DISTRIBUTION OF LANDS USED AS PASTURELAND BY MAJOR SOIL CLASS AND SUB-BASIN, OHIO RIVER BASIN, 1958

exists for pastureland conversion to crop uses if the demand for agricultural products is sufficient. The more productive pastureland soils often are inaccessible and in small geographic locations. Consequently, the costs for bringing these lands into crop production would be increased.

Major Land Use

Slightly over half of the rural land in the Ohio River Basin in private ownership is in crop and pasture use (Table 3). About forty percent is in forest use. Other land which includes farmsteads, farm roads, levees and swamps involves less than a tenth of the area. Urban land ownership, public roads and other public land ownerships are excluded from these statistics.

Sub-basins south and east of the Ohio River have higher proportions of their land in the forest and pasture categories. Sub-basins such as the Wabash and Scioto have relatively large amounts of cropland.

As indicated previously, soils, topography and climate influence the major land-use patterns. These factors can be expected to have a significant effect on future land-use patterns as well.

For a more detailed report on current land-use, production and cropping patterns refer to a previous report on this Basin by this agency.[1/]

[1/] Lea, Dallas and Russell, J. R., "The Agricultural Economy of the Ohio River Basin," Resource Development Economics Division, ERS, USDA, March 1964.

Table 3. Distribution of Land Use, by States and Sub-basins, Ohio River Basin, 1958

State and Sub-basin	Cropland	Pasture	Forest 1/	Other	Total
	Acres				
State: 2/					
New York	435,384	268,789	629,580	184,244	1,517,997
Pennsylvania	2,057,487	917,815	4,818,331	1,115,640	8,909,273
Maryland	66,912	41,056	292,736	19,450	420,154
Ohio	7,943,328	2,938,574	4,425,056	1,286,125	16,593,083
Indiana	10,963,100	1,949,978	3,304,369	1,481,692	17,699,139
Illinois	4,501,842	837,963	1,127,147	135,072	6,602,024
Virginia	276,309	729,551	1,356,745	9,760	2,372,365
West Virginia	1,160,334	2,222,936	8,024,140	319,079	11,726,489
North Carolina	90,000	167,400	315,800	25,700	598,900
Kentucky	5,673,908	4,838,394	10,784,678	1,883,571	23,180,551
Tennessee	1,169,722	1,341,805	3,121,785	550,534	6,183,846
TOTAL	34,338,326	16,254,261	38,200,367	7,010,867	95,803,821
Sub-basin:					
Allegheny	1,457,095	635,785	3,942,240	797,936	6,833,056
Monongahela	529,062	907,197	2,124,363	218,217	3,778,839
Pittsburgh SMSA	469,978	260,049	647,199	254,699	1,631,925
Beaver	616,821	197,203	543,499	240,408	1,597,931
Upper Ohio	575,245	710,714	1,485,979	279,448	3,051,386
Muskingum	1,749,129	1,073,991	1,230,164	635,216	4,688,500
Kanawha--Little Kanawha	824,174	1,764,075	5,191,282	148,047	7,927,578
Ohio--Huntington	597,732	626,427	2,201,129	193,986	3,619,274
Scioto	2,519,782	493,826	546,124	103,537	3,663,269

Table 3 Continued--

Table 3. Distribution of Land Use, by States and Sub-basins, Ohio River Basin, 1958 (CONT.)

State and Sub-basin	Cropland	Pasture	Forest 1/	Other	Total
	Acres				
Sub-basin (cont.):					
Guyandotte - Big Sandy Little Sandy	151,480	221,692	3,118,737	241,553	3,733,462
Ohio - Cincinnati	828,208	600,663	724,849	134,233	2,287,953
Little Miami - Miami	2,694,471	495,624	447,103	78,031	3,715,229
Licking, Kentucky, Salt	1,434,099	2,341,422	3,293,462	550,815	7,619,798
Ohio - Louisville	686,884	372,468	894,894	214,028	2,168,274
Lower Ohio - Evansville	1,985,908	773,531	1,260,791	395,523	4,415,753
Green	1,711,915	904,485	1,996,644	372,133	4,985,177
White	4,601,800	915,066	1,699,249	723,716	7,939,831
Wabash	8,809,648	1,159,430	1,362,979	531,745	11,863,802
Cumberland	2,094,895	1,800,613	5,489,680	897,596	10,282,784
TOTAL	34,338,326	16,254,261	38,200,367	7,010,867	95,803,821

Source: National Inventory of Soil and Water Conservation Needs

figures are calculated as residual from
data assembled for

1/ Forest acreage data based on ~~information from~~ the Conservation Needs Inventory ~~only~~ and differs somewhat from official U. S. Forest Service estimates which are based on a different sampling technique.

2/ Acreages pertain only to that portion of the state in the Ohio River Basin.

BASIN AGRICULTURAL PRODUCTION POTENTIAL

The purpose of this part of the report is to indicate the supply potential of the agricultural resources in the Basin to produce the expected demand for food and fibre. The important variables in the analysis of the agricultural supply potential are: (1) crop and forage production technology, (2) nonagricultural uses of agricultural land, and (3) the relative costs of producing agricultural products in the Land Resource Areas and sub-basins. Information relevant to these variables in the Ohio study are discussed in the following paragraphs.

Crop and Forage Production Technology

A contract was entered into with the Ohio Agricultural Experiment Station to analyze the prospective changes in crop and livestock production technology and to estimate the yield level for the various crops on the major soils in the Basin. The following paragraphs through page 27 represent a summary of the informal report prepared by the Ohio Station.1/

General Crop Production Limitations

1. Available energy from the sun is the ultimate limitation on the yield of green plants; they cannot build more calories than the

1/ Willard, C. J., "Projected Crop and Pasture Yields, Associated Fertilizer Use and Feeding Efficiencies, Ohio River Basin, 1980-2010," 200 pages, unpublished report of the Ohio Agricultural Experiment Station.

sun delivers. Crop production per acre in the humid area of the U. S. may be reaching this limitation. Yield is the difference between photosynthesis and respiration and either may limit yield levels.

2. Plant nutrients are the limiting factors under human control. Obviously, any future increase in yield will come from furnishing more fertilizers to our crops. Level of nitrogen, phosphorus, potash and lime application will limit crop and pasture production.

3. The physical nature of the soil will affect future yields. The physical condition of the soil often can be improved. Production on eroded, stony and shallow sods will be limited. Likewise, soils with low water-holding capacity or low infiltration rates will influence yield levels.

4. Drouth represents a limitation on crop yields. Much can be done to conserve the water falling on the soil and conversely get rid of water before it harms yields. Irrigation and drainage depend upon the availability of water and adequate drainage outlets.

5. Almost every crop grown in the Ohio River Basin is being improved by breeding and this will continue for the foreseeable future. Improvements in insect and disease resistance can be expected. Gains from better varieties likely will be second only to those from fertilizer.

Expected Changes for Individual Crops

Corn. Large advances in corn production per acre have been recorded in the last three decades. Hybrid seed, heavy nitrogen application, thicker planting and improved cultural practices have contributed to the yield increase. Yields will improve. The question concerns whether they will improve as fast as in previous decades. Yields will be increased through --

a) improved hybrids for yield characteristics,

b) improved disease and insect resistance,

c) improved resistance to lodging (especially with high plant populations), and

d) improved grain to stalk ratios (shorter stalks).

Regression analyses indicate that the current average annual technology increase is slightly less than one bushel per acre per year for the soils now being used to produce corn. This rate was assumed to continue until 1980, then decline to about two thirds of a bushel for the rest of the production period. Present average corn yields are lower in the Land Resource Areas south of the Ohio River. Yield increases are estimated to be higher in these areas as corn-growing techniques are expected to catch up in this region.

Corn Silage. Factors pertinent to corn grain production are relevant to corn silage production. Thicker planting, higher nitrogen fertilization and other cultural methods will increase yields. An analysis of Agricultural Census yields indicates yearly gains from

technology on the soils now used of 0.13 ton per acre. This rate was continued to 1980 and reduced about 20 percent thereafter.

Soybeans. Soybeans utilize large amounts of nutrients yet show little response to direct fertilization. Soybeans usually follow heavily fertilized corn in a rotation. Phosphorus and potash applications are used when soybeans are sown on soybean ground. Nitrogen has yet to show satisfactory gains. Probably sources of increased yields are:

a) improved fertilizer technology,

b) improved varieties to minimize shattering and harvest wastage, and

c) improved varieties to decrease lodging.

Regression analyses indicate that currently soybean yields are increasing about a third of a bushel per year per acre. This rate is estimated to continue until 1980 and then reduce 20 percent for the balance of the projection period.

Wheat. The Ohio River Basin produces soft red winter wheat entirely. The high protein (hard red) wheats probably will not be grown in this area. The climate of the Basin, in general, is too moist for best wheat production. Some experiments show a negative relationship between rainfall and wheat yields. Wheat varieties still are being improved. Hybrid wheat is now a real possibility which may confound the predictions. Wheat yields can be improved through:

a) shorter straw with less lodging and higher proportion of the photosynthate available for grain,

b) greater winter hardiness

1. resistance to direct cold

2. resistance to heaving

3. greater dormancy,

c) resistance to diseases and insects.

An analysis of yield trends over a 33-year period indicates that wheat yields currently are increasing about one-half bushel per year on soils presently used for production due to improvements in technology. This rate was continued to 1980 and was reduced to about one-third of a bushel per year for the projection period after 1980.

Wheat responds especially to phosphorus. Yield response to potash is usually small. Some nitrogen at planting time is essential, but the greatest requirement is at tillering. To avoid leaching additional nitrogen is usually top-dressed in the early spring.

Oats. Both winter and spring oats are grown in the Ohio River Basin. Spring oats, a crop of the cool moist season, is grown in the northern part of the Basin. In Kentucky and the southern fifth of Illinois, oats are largely winter oats. Winter oats out-yield spring oats where they do not winterkill. They are not yet a safe crop in Ohio or Indiana.

The oats produced in Tennessee and Kentucky will eventually be winter oats by 1980 and 2010. Yield improvements will depend on

the success of the oat breeders in producing winter oats which are resistant to a number of diseases. Winter oats could easily be more important and certainly higher yielding.

If soils now devoted to oats were kept in oats production, yields would be expected to increase about a half-bushel per acre per year until 1980 and then a third of a bushel per acre per year in the later part of the projection period.

Barley. Both winter and spring barley are grown in the Ohio River Basin. Spring barley, like oats, is a cool-season crop. It requires a relatively high soil pH which results in poor yields in a large part of the Ohio River Basin unless lime has been applied. Since barley is a relatively minor crop, research to improve varieties and management practices probably will not be intensive; therefore, yields are estimated to increase about an eighth of a bushel per year due to technological change throughout the whole projection period.

Tobacco. Tobacco yields in the Ohio Basin have nearly doubled in the last 30 years. Burley, a cigarette tobacco, makes up the major proportion of the crop. Cigar tobaccos may become more important. An analysis of yield trends indicates that tobacco yields are increasing about 20 pounds per year. This rate is expected to continue until 1980, then decrease to about ten pounds per acre per year after 1980.

Potatoes. Potatoes are especially adapted to loose, rich, well-aerated soils, and hence are especially grown on the peats, mucks, sandy loams and the lighter soils in general. Potatoes thrive on a

cool, moist climate. Yields have increased phenomenally in Ohio and Indiana. Other Ohio Basin states have lagged behind but are expected to catch up. In general potato yields are expected to increase about 2.5 hundredweight per acre per year for the projection period.

Miscellaneous crops. Yields of sweet corn for processing have increased sharply in recent years in Ohio, Indiana, and Illinois. Favorable climate may have influenced yields. Other Ohio Basin states produce very small amounts of sweet corn. Yields are projected to increase one hundredweight per acre per year until 1980, then the rate will lower to two-thirds of a hundredweight.

Indiana, Ohio and Illinois are leading states in tomato production. "Once over" mechanical pickers are being used. Varieties for such picking are being developed. Lower yields may result but yields are expected to increase 600 pounds per acre per year until 1980, then increase only about one-third of that amount per year to 2010.

Snap beans average 42 hundredweight per acre now and are projected to reach 57 hundredweight by 1980 and 80 hundredweight by 2010.

Fruit. West Virginia and Ohio are the leading apple and peach producers in the Ohio Basin states. Fruit yields are expected to increase through more trees per acre. New orchards probably will use more dwarf stock. Apple yields are projected to double by 2010 with a 40 percent increase by 1980. Peaches are expected to increase 15 percent by 1980 and 30 percent by 2010.

Forage yields. Scientists indicate that greater yield increases can occur in forage production than in grain production. But forage

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

yields have increased little in the last 35 years--slightly less than 20 percent. Yields are expected to increase through improved varieties that are disease resistant. Alfalfa and clover-timothy mixtures are expected to increase about a quarter of a ton per acre each decade. Lespedeza yields are not expected to increase materially.

Pasture Yields. Pastures can easily be made to produce at least two or three times more than they do. The three general methods of pasture improvement will be:

1) Mechanical -- clipping weeds and brush, removing trees, etc.
2) Application of lime and phosphate or phosphate-potash fertilizers which bring in legumes -- these in turn build up nitrogen and increase the grass.
3) Direct application of nitrogen to increase grass yields.

Pasture yields overall are expected to increase about 10 percent by 1980 and approximately 20 percent more by 2010. These projections may appear low but pastures are the last part of the farm to be improved, and receive the least improvement.

Nonagricultural Uses of Land

Population pressures are expected to have a continued impact on the use of rural lands. Urban areas especially are expected to expand to provide home sites, service and industrial development areas. In rural areas, highways and recreation areas are expected to require more land. All of these uses are considered higher uses of the land

in an economic sense. The procedure in this study is to estimate the amount of farm land for these purposes in the projection years, then subtract these acreages from the land available for agricultural production.

Total population in the Ohio Basin is expected to reach 22.7 million in 1980 and 31.7 million in 2010, compared with the 1960 total of 19.0 million. Urban population will grow more rapidly than the total from 10.9 million in 1960 to 14.8 in 1980 and 23.0 million in 2010 (Table 4). The urban population thus will represent 72.5 percent of the total in 2010, compared with 65.3 percent in 1980 and 57.6 percent in 1960.

Table 4. Total and Urban Population, 1960 and Projected Population, 1980 and 2010, Ohio River Basin

	1960	1980	2010	Percent Change From 1960-80	Percent Change From 1980-2010	Percent Change From 1960-2010
	-------	000	--------	----------	Percent	------------
Total Population	19,001	22,669	31,713	19.3	39.9	66.9
Urban Population	10,951	14,806	23,001	35.2	55.3	110.0
Percent Urban	57.6	65.3	72.5			

Source: Appendix B, Ohio River Basin Comprehensive Survey Report

Given the expected increases in population, the amount of land needed to accommodate the larger number of people will depend on the population density. Population density has a direct relationship to

homesite, service and industrial development land use. An examination of current and past relationships between population and land area is used to provide a basis for making nonagricultural land use projections.

The Bureau of the Census has published the land area and population of incorporated places of 2500 or more in 1950 and 1960. Data were available for most of these places in the Ohio Basin. Changes in land area and the changes in population that occurred from 1950 to 1960 were determined. While most cities increased in both population and land area during this period, some of them decreased in one or both of these characteristics. Downward adjustments in population occurred more than twice as frequently as decreases in land area. This was not surprising, as cities would not likely give up incorporated areas even though population declined. In the larger cities the drop in population reflected the well-known "flight to the suburbs," with land in commercial and industrial uses in the central city gaining at the expense of residential land. Satellite cities absorbed the former residents of the central city. In the smaller cities, the shrinking population may have been indicative of general declines over relatively large geographic areas, resulting in vacant dwelling units and business buildings with little or no changes in city boundaries. Losses in population of individual cities varied from less than 100 to more than 70,000 while losses in land area ranged only from one-tenth of a square mile to 8.1 square miles.

Increases in both population and land area were noted for most of the urban places in the Basin. Increases ranged from as little as 10 persons in small cities to more than 20,000 for some of the major cities. Likewise, increases in land area ranged from one-tenth of a square mile to more than 10 square miles. (Columbus, Ohio rose in population by 95,000 and in land area by 50 square miles.) Changes in population density were expected to be related to population of the city in 1950. However, the differences among the various city sizes was not statistically significant. The average relationship between population growth and increase in land area was approximately .3365 acres per person. An increase in land area of about 336.5 acres was associated with an increase of 1000 in the population.

As urban areas increase in size and complexity, there may be a reversal of the present suburban migration. Such a reversal could result from difficulties in traveling long distances to and from work or upward pressure on suburban land values relative to those in the central cities. On the other hand, there is some justification for a belief that the suburban, low-density type of urban development will be even more important in the future than in the past. Higher incomes and increased amounts of leisure time have been projected for the future. Both of these factors might be associated with further decentralization within metropolitan areas. Also, the rural nonfarm population, which has a density even lower than that of the suburbs is expected to increase rapidly, although it will likely represent a declining proportion of the total. This would be another factor

offsetting any tendencies toward an increase in population density in urban areas. Consequently, an estimate of 336.5 acres per 1000 increase in population appeared reasonable.

The above estimate included only land inside the corporate limits of urban places. Highways or recreational land outside the corporate limits were not considered. Between 1960 and 1980, highways were estimated to require 22.66 acres per 1000 increase in population in areas north of the Ohio River and 33.24 acres in areas south of the river. The difference was due to the fact that the interstate highway system was more nearly complete north of the river than south of it. By 1980, the interstate system was assumed to be completed and the highway requirement from 1980 to 2010 was estimated at 20.0 acres per 1000 increase in population. Highway land-use estimates were based on available information on proposed highway development in the respective states.

The requirement for recreational land is difficult to estimate since some recreational land is included within corporate limits of urban places. The rate of nine acres per 1000 population increase was used for parks and recreation outside of cities between 1960 and 1980 and also between 1980 and 2010. This estimate was based on the requirement for urban fringe areas, from material on land used prepared by city planning officials.

The total land requirement for "living space" for the urban population increases expected between 1960 and 1980 thus averaged about 368 acres per 1000 for areas north of the Ohio River and 379

acres south of it. Between 1980 and 2010 the figure was expected to drop to 365.5 acres for both north and south. These figures were applied to the population increases projected for each Land Resource Area in the Basin. About 1.4 million acres more land would be required for urban uses in 1980 than in 1960, and almost 3 million additional by 2010. Thus the amount of urban land in 2010 would be 4.4 million more than in 1960. For comparison purposes the latter amount represents 4.7 percent of the 94.3 million acres of the Ohio Basin land which was not in urban uses, highways and federal ownership in 1959.

In order to determine more accurately the qualitative effect of land-use changes estimates were made of the amount of land in each land class, as measured by the Conservation Needs Inventory, that would go into urban uses. About half of this land is in Class II and over three-fourths is in Classes I-IV. Most of the land in these classes is now devoted to agriculture, so the loss in agricultural production will be greater than if the land were divided more nearly equally among the classes. Some of the urban development projected will have impact on other rural lands such as forests and woodlands and areas not in farms. After their deduction, the impact of crop and pasture land in farms is expected to be slightly less than one million acres in 1980 and 2.7 million by 2010 (Table 5).

Table 5. Expected Nonagricultural Use of Existing Crop and Pasture Land in Farms, Ohio River Basin, 1980 and 2010

	Sub-basin	1960-1980	1960-2010
		------------000 Acres------------	
A	Allegheny	25.9	88.3
B	Monongahela	9.0	34.7
C	Pittsburgh SMSA	18.8	58.8
D	Beaver	25.7	81.5
E	Upper Ohio	18.3	57.6
F	Muskingum	48.1	156.7
G	Kanawha - Little Kanawha	8.6	34.9
H	Ohio - Huntington	10.0	33.9
I	Scioto	92.0	270.6
J	Guyandotte -- Big Sandy Little Sandy	.4	2.0
K	Ohio - Cincinnati	44.3	131.3
L	Little Miami - Miami	108.8	316.1
M	Licking, Kentucky, Salt	84.4	252.8
N	Ohio - Louisville	19.4	57.9
O	Lower Ohio - Evansville	7.5	28.6
P	Green	8.9	30.7
Q	White	119.0	353.9
R	Wabash	226.8	675.4
S	Cumberland	32.6	95.1
	TOTAL	908.5	2,760.8

Production Costs

Production cost data were developed on the basis of current input price levels and relationships. Cost budgets were adapted from the work of Blosser in Ohio and specialists at the various agricultural experiment stations in the Basin.[1/] All items of on-farm production costs were included with the exception of charges for crop storage

[1/] Blosser, R. H. Crop Costs and Returns in West Central Ohio, Ohio Agricultural Experiment Station, Wooster, Ohio, Research Bulletin 909, June 1962.

and land. The per acre production costs for each crop and soil were aggregates of three major types of costs--preharvest costs, harvesting costs and the cost of materials. These costs were developed by applying an hourly charge against the time required to perform each operation. For instance, charges were based on the costs of operating a three-plow tractor and the appropriate equipment for that power source and annual use rate (Table 6). Labor costs were figured at $1.50 per hour. Nitrogen, phosphorus and potassium fertilizer costs were 12, 10, and 5 cents per pound of actual nutrients applied. Rates varied somewhat by Land Resource Area according to historical price relationships.

Preharvesting costs consisted of charges for land preparation, planting and cultivation in general. However, there were additional charges for side dressing with fertilizer and spraying with insecticides and herbicides for certain crops. Charges were made for clipping cropland pasture and permanent pasture also. A miscellaneous labor charge was made for minor equipment maintenance, refilling of planter with seed and fertilizer, fueling and greasing of equipment and equipment changing.

Harvesting costs included the time necessary to harvest the crop and in addition, included the costs of equipment and labor needed to transport the crop to the on-farm storage facility. Off-farm transportation costs were not included in production costs.

Harvesting and materials cost varied over the projection years as yields per acre increased. The cost of materials varied among

Table 6. Typical Annual Use and Cost Rates for Farm Equipment, Ohio River Basin Study, 1960 Price Level 1/

Implement	Hours Used Per Year	Rate Per Hour
	--Average-	Dollars
Tractor (3-plow)	600	$1.30
Plow (3-14")	100	.80
Disk Harrow (10 ft.)	100	.60
Drag Harrow (10 ft.)	60	.12
Planter (4-row)	40	1.75
Rotary Hoe (4-row)	40	1.43
Cultivator (4-row)	100	.95
Sprayer (8-row)	40	.57
Corn Picker (2-row)	100	3.50
Combine (7-ft.)	100	5.00
Mower (7-ft.)	60	1.00
Haybaler (40 brs.)	40	6.40
Hay Rake (7-ft.)	60	1.10
Grain Drill (15 x 7")	60	2.00
Hired Labor	--	1.50

1/ Rates varied somewhat for each Land Resource Area according to historical relationships. Detail cost and machinery performance rates for each land capability group in each LRA are on file.

[illegible]

crops more than did the costs of planting and harvesting. Increased fertilizer use made up the major portion of the change in materials costs. Other material costs included such items as lime, seed, spray, twine for hay baling and bags for potatoes.

Assumptions and Limitations

The most critical variables in the analysis of the agricultural supply potential of the Ohio Basin are crop yields and production costs. While the crop and pasture yields are based on the best knowledge that can be assembled at this time, the yields may not reflect actual average conditions in the future. Estimates of the future must, of necessity, be based on present knowledge. Should any of the yield trends be different than those estimated, the projected production patterns and associated agricultural water-use relationships could be in error. Undoubtedly, many unknown factors could influence the level of future yields. Users of the projections, especially estimates in the distant future, should keep this limitation in mind.

Production costs used for the crop and pasture budgets utilize current price levels and relative prices for the inputs in the production process. The use of current price levels is in keeping with the study procedures of evaluating the future in terms of prices at current levels. A constant adjustment in the overall price level would have no effect on the production patterns as analyzed here. However, the relative price level among production items may not remain the same in the future (i.e. fertilizer prices, hired labor

rates, machinery costs, etc.). To the extent that the price relationships should vary, the projected production patterns among Land Resource Areas might also vary. The production cost data used are the best estimates possible within the limits of this study.

NATIONAL FOOD AND FIBRE REQUIREMENTS

As indicated in previous sections, an estimate of the United States farm products that consumers will purchase in the projection years is necessary. In the operation of the projection model, an estimate of the aggregate production requirements for the Ohio Basin also must be known. The model through the economic budgeting technique then simulates Ohio Basin farmers' decisions in using their land resources to produce the Basin's share of needed agricultural production.

National requirements for agricultural production result from three major economic forces: (1) growth in population, (2) changes in per capita consumption rates and livestock feeding efficiencies, and (3) changes in the import-export balance for agricultural commodities. The following paragraphs discuss the basis for the national requirements used in this study, then indicate the procedure for determining the national requirements that will likely come from the Ohio Basin.

National Needs

Projected domestic requirements are derived by multiplying the projected per capita utilization rates by the population assumed for 1980 and 2010. The population projections used were those adopted for the Ohio River Basin Comprehensive Survey and used in the

nonagricultural aspects of the economic base study conducted by the private consultant. The projections represent a moderate growth rate but still represent a two-fold increase from 1960 to 2010 (see Table 1, page 12).

Per Capita Utilization

Per capita consumption rates depend upon levels of disposable incomes and consumer tastes. Gross national product is expected to grow at an average rate of 3.3 percent. Accordingly, per capita incomes are expected to increase 237 percent between 1960 and 2010.[1/] Consumer preferences for agricultural commodities are related to income levels. Consumers' diets are not expected to change significantly after 1980 even though disposable incomes increase. In other words, the income elasticity of demand for food will be very low--especially at the levels projected. Accordingly, identical per capita rates were used for 1980 and 2010.

Consumers are expected to increase their use of beef and poultry products (Table 7). Other meat and dairy products will be consumed at lower than current rates. Soybeans use will increase by two-thirds but cereals such as wheat and rye will be confronted with reduced rates of consumption. Sweet potatoes and drybeans also will have reduced rates. Other products are expected to have consumption rates similar to those of today.

[1/] Op. cit., "Projective Economic Study of the Ohio River Basin." pp. 5 and 16.

Livestock Feeding Efficiencies

The efficiency expected in converting grain and roughages into livestock products has an important bearing on the feed and pasture requirements in the Nation. Since the Ohio Basin encompasses considerable portions of the principal feed-grain producing area in the United States, the assumption about feed conversion in the study is even more important. The following paragraphs through page 44 represent a summary of the report prepared by the Ohio Experiment Station concerning feeding efficiencies.[1/]

New knowledge of genetics has enabled livestock breeders to improve their animals with much greater certainty. The new knowledge of nutrition has constantly increased the efficiency with which feed is utilized, and new information concerning animal physiology has made progress on many fronts possible.

Utilization of the new knowledge has not come to all livestock equally. With large animals and their slow reproduction, progress has not been as rapid as with smaller animals. Producers of chickens, because chickens are the smallest and hence least expensive animal with which to work, have made perhaps the greatest progress in utilizing scientific information. The production of eggs per bird and meat per pound of feed obtained today would have been impossible even thirty years ago. Because of the short life cycle of hogs and their rapid reproduction, producers of swine have benefited greatly

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[1/] Op. cit., "Projected Crop and Pasture Yields, Associated Fertilizer Use and Feeding Efficiencies, Ohio River Basin, 1980-2010."

from this new information. Record keeping has been an important factor in increasing milk production in recent years. However, the breeding of cattle particularly for beef production by other than "stock judging" methods dates back less than 20 years. The progress in these fields is proceeding rapidly.

Feeding efficiency, for purposes of this study, is defined as the amount of product obtained for a feed unit. A feed unit is defined as a pound of corn, or, since corn is far from an ideal feed for most of the livestock involved, its energy equivalent. The factors of better breeding, better control of environment, better control of diseases, more knowledge of nutritional requirements and so on, all combine to increase feeding efficiency. Feeding efficiencies cannot increase indefinitely, however. The ultimate limit of feeding efficiency is the energy value of the feed used, less the amount of energy required for the maintenance of the animal. As yet we are not approaching this limit.

The feeding efficiencies developed are projections of the average feeding efficiency--not what can be produced experimentally (Table 8). Experimental production at this time has almost or actually equaled the estimates given for 2010. The efficiencies for beef cattle and sheep are higher because of the maintenance requirement of the cow and ewe during the period that the calf or lamb is being produced.

A factor influencing the projections concerns the extent new practices will be adopted by farmers. Livestock farming more and

Table 7. Projected Per Capita Uses of Major Farm Products, United States

(1959-61 = 100)

Item	Projected Use
Meat (carcass weight)	
Beef	132
Veal	85
Lamb and mutton	71
Pork (excluding lard)	89
Total	111
Dairy products	
Fluid milk and cream	
Other	
Total milk equivalent (fats solids basis)	87
Poultry	
Chicken (ready to cook)	120
Turkey (ready to cook)	157
Total	127
Eggs	86
Soybeans	164
Flax	57
Wheat	87
Rice (milled basis)	106
Rye	78
Peanuts (farm stock basis)	103
Sugar crops (raw equivalent)	100
Fruits	
Citrus (fresh basis)	102
Noncitrus	107
Tree nuts (in shell)	94
Vegetables (all, including melon)	103
Potatoes (fresh and processed)	112
Sweet potatoes	72
Dry beans	92
Dry peas	100
Wool (apparel, scoured)	100

Source: Estimates developed by the Economic Framework Section, River Basin and Watershed Branch, Resource Development Economics Division in conjunction with the Economic and Statistical Analysis Division of the Economic Research Service.

Table 8. Feed Units Required Per Pound of Product (live weight) 1/

Time Period		Beef and Veal	Lamb and Mutton	Pork	Milk	Broilers	Turkeys	Eggs
Present:	Estimated	11.5	13.0	4.6	1.0	3.0	3.7	3.6
1980:	Projected	10.5	12.0	4.0	0.85	2.5	3.2	3.1
2010:	Projected	8.0	9.0	3.5	0.7	2.2	2.7	2.5

1/ One feed unit is the equivalent of one pound of corn.

more is done on a large scale specialized basis. New developments are expected to be adopted more rapidly than in the past.

The following factors for each major livestock class indicate some of the direction that technological progress is taking.

Factors Affecting Future Beef Production

1. Growing out dairy calves, for which cow maintenance charges can be reduced, will give considerable beef. More beef will come from cull dairy cows.
2. Beef will not be fed to present levels of fatness. Feeding efficiency will continue to increase.
3. Breeding for beef will increase amount and quality of beef production per 100 pounds of feed.
4. Cross-breeding (wide crosses only) will introduce hybrid vigor.
5. Hormones in feeding will still give some increase in production to 1980.
6. Fattening bulls instead of steers will increase the amount of beef produced per 100 pounds of feed.
7. Corn stalks, straw, and other material now used only for soil improvement will be used more effectively.
8. Artificial insemination may require too much watching of the herd to be practical until it is feasible to control estrus, but that may not be far away. By 1980 small herd owners should be able to buy sons of progeny-tested bulls as herd headers.

9. Marketing calves around 800-900 pounds without weaning gives very economical beef in terms of feed required per 100 pounds gain.
10. Scrub cows will considerably be eliminated as "beef" cows, even by 1980, much more by 2010.
11. Improved marketing will give better utilization, so the consumer will get more beef out of that produced.

Factors Affecting Future Sheep Production

1. Selection for multiple births is a vital necessity if sheep are to survive as a farm animal in the Ohio Basin. Twin-bearers increase gross income per ewe by 80 percent.
2. A new and safer vermifuge (safe up to 10 to 20 times the therapeutic dose) has recently become available.
3. Lambs can be weaned at 60 days, making it feasible to obtain two crops of lambs a year or at least three lamb crops in two years.
4. Artificially induced estrus may make possible control of lambing, particularly the season of lambing.
5. Feed is required to make wool, but this is charged to meat production in the Table.
6. There is a poor market for fat old ewes--5 cents per pound versus 20 cents for fat old cows, in November 1962.
7. Many growers have been driven out of the sheep business by dogs.
8. The labor cost of butchering sheep and lamb is greater per pound than for cattle, since more units must be handled to get the same tonnage.

Factors Affecting Future Pork Production

1. Breeding for economy of feeding and higher percent of lean ("meat type").
2. Improved housing, controlling the environment--temperature and humidity. (Uniform cool temperature is fine for hogs.)
3. Continued improvements in feeding, including limited feeding after 100 pounds to reduce percentage of fat and increase efficiency of feed utilization.
4. Artificial insemination, coupled with hormones to bring sows in heat at one time.
5. Feeder pig production, making possible greater specialization, is becoming a large factor in pork production.
6. Larger litters are vital for economical production.

Factors Affecting Future Dairy Production

1. Increased health of cows, disease control. There should be breakthroughs in controlling mastitis and bloat.
2. Better feeding--high-quality forage and more feed. (Present genotypes with good feeding will produce 9,000 to 12,000 pounds milk per year. Above that production a higher proportion of the gain will come from breeding better genotypes.)
3. Better breeding. Stamina, longevity, and reliable breeding are important areas of improvement.
4. Better milking techniques.
5. Labor-saving efficiency--by 1980, 1,000,000 pounds milk per year per three men will be general, though hardly the average.

6. "Protective" milks are a possible plus factor.
7. Artificial insemination will continue to give large gains multiplying productive genotypes.
8. An effective test for solids not fat and change to evaluating milk on that basis, or total solids, would be an important practical help to the dairy industry.

Factors Affecting Future Poultry Production

1. Better housing--ventilation to take the water out of manure will reduce respiratory diseases.
2. More knowledge of physiology of the birds.
3. Better disease control, though already at a high point.
4. Further progress in breeding in all directions.
5. Continued study of feeding efficiency.

Import-Export Balances

The level of exports of agricultural commodities to foreign nations can have a significant impact on domestic land use. The estimate of likely import-export balances is difficult. Nevertheless, the analyses and judgments of commodity specialists and experts in foreign agricultural development provide a logical basis for these projections. The principal assumption with respect to exports is that significant increases can be expected to 1980. However, developing nations are expected to become less dependent upon the United States for food; consequently, exports are expected to level off after 1980. For this reason, identical import-export balances were used for 1980 and 2010 in determining total United States product requirements.

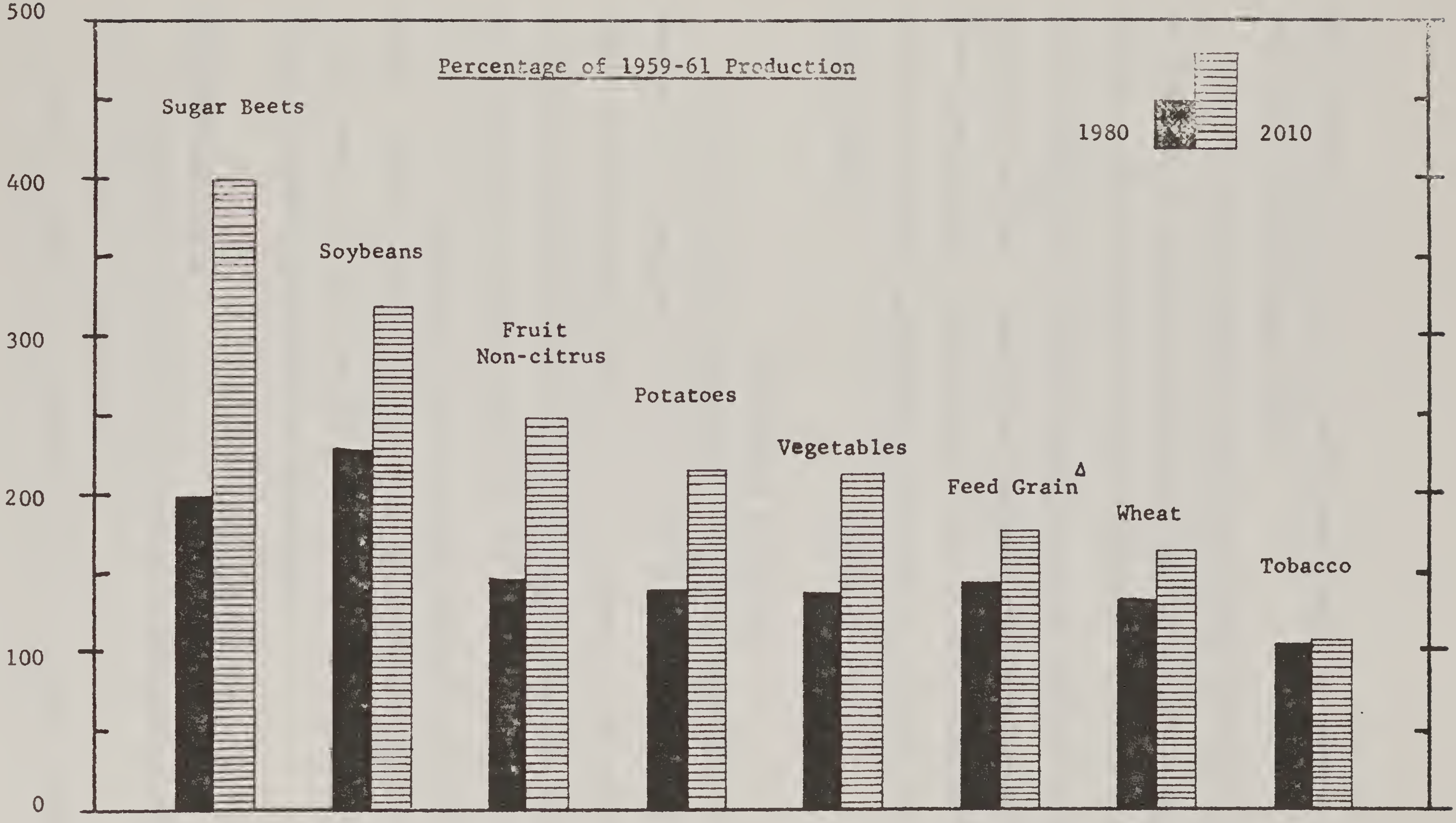
The export of food crops is expected to increase about 100 percent. Wheat and soybeans are the principal export items. Minor food crop exports such as peas, dry beans and vegetables will have a smaller share of the export market. Currently food crop exports represent about 15 percent of the food crops produced in the United States.

Feed crop exports will increase about 80 percent over current export levels. Corn is the principal feed crop exported. Barley, grain sorghum and oats also are exported. The increase is expected to be almost entirely corn. Currently slightly less than 10 percent of the feed crop is exported.

Livestock imports and exports are expected to balance, consequently the domestic requirements reflect total livestock product needs for the United States.

Projected Field Crop Requirements

When all factors are considered, the production needs for field crops in 1980 increase from 40 to 100 percent (Figure 9). Soybean production will need to increase 125 percent. Need for increased tobacco production will not be great. The production requirements by 2010 for sugar beets represent a four-fold increase over current levels. Sugar beets, like noncitrus fruit, potatoes and vegetables are minor crops as far as acreage requirements are concerned. Soybeans, a major crop with more than a two-fold increase by 2010, will require considerable acreages of Ohio Basin cropland. Feed crop and



* Assuming U. S. population of 244.8 million in 1980 and 378.2 million in 2010

Δ Includes corn, barley, oats and sorghum

FIGURE 9. PROJECTED REQUIREMENTS OF FIELD CROPS, U. S., 1980 and 2010*

wheat acreages also will be sizeable even though the relative increase over present levels appears small.

The per capita consumption rates for poultry and beef when coupled with the projected population, call for a sizeable increase in these items in both 1980 and 2010 (Figure 10). Consumption rates for pork, eggs, milk and mutton call for smaller relative increases in product required. Even so the absolute increase required for these items is large. The projected levels of crop, vegetable and livestock production requirements for the Nation are shown in Appendix Table 1.

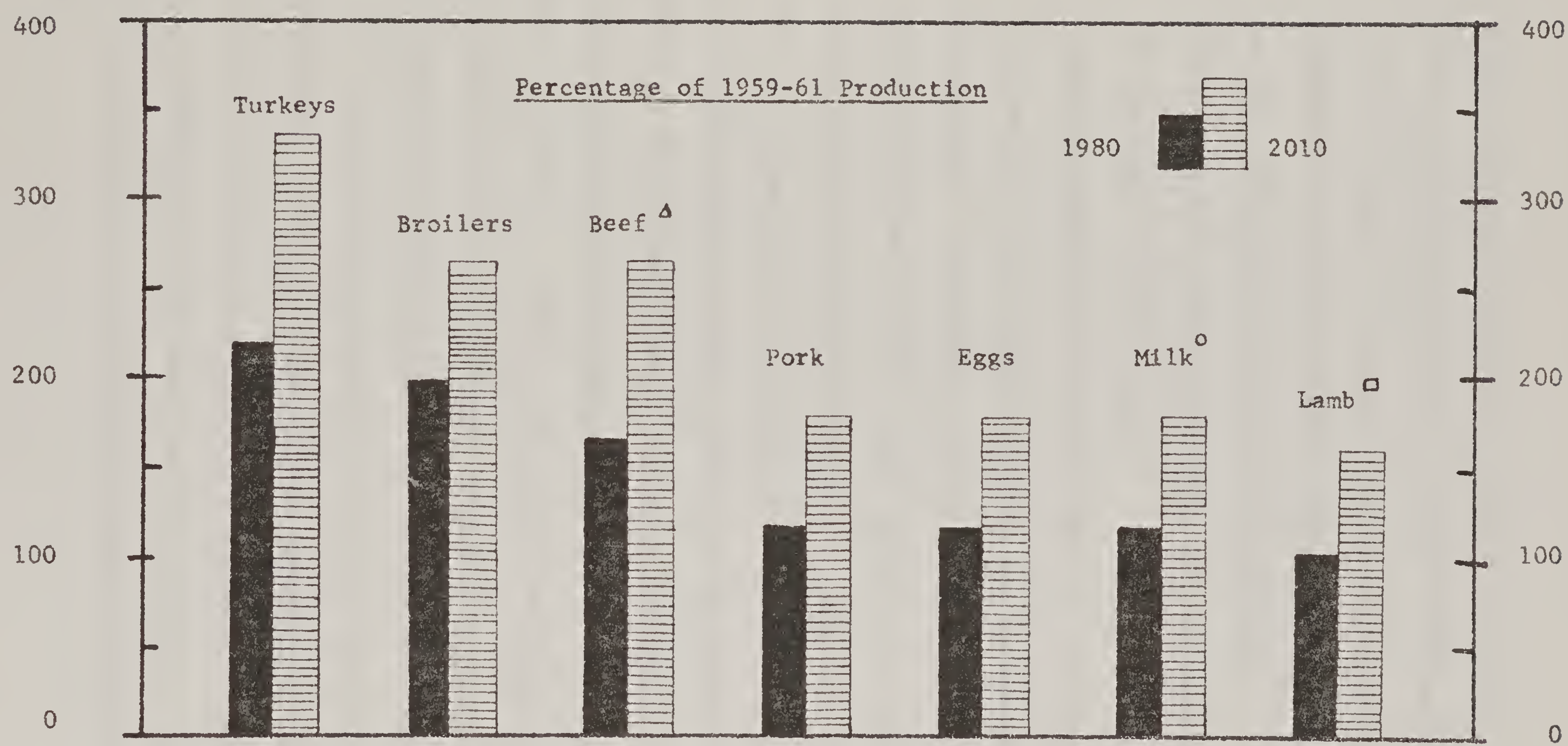
Ohio Basin Production

The future national agricultural production requirements expected to be produced in the Ohio River Basin were developed primarily on the basis of historical relationships. Existing trends of regional shifts in production were considered. Ideally an analysis of all major water resource regions should be made simultaneously. This will be attempted in the OBE-ERS inter-regional study now in process. But for this study only trends in regional production patterns were taken into account; however, commodity specialists reviewed the Basin allocations for consistency.

Allocation Procedures

In developing the regional projections of agricultural production the following procedure was used:

1. A series of tables was prepared for each of the major commodity



* Assuming U. S. population of 244.8 million in 1980 and 378.2 million in 2010.

Δ Including veal o Including all dairy products □ Including mutton

FIGURE 10. PROJECTED REQUIREMENTS OF LIVESTOCK PRODUCTS, U. S., 1980 and 2010 *

groups showing the quantity produced in the Ohio Basin states and in the United States for the years 1939 to 1963.

2. The percentages of the United States output that has been produced or is being produced within the Ohio Basin was computed and the relationship developed statistically.
3. These basic data were supplemented with comparable information for the major competing areas.
4. Commodity specialists of the Economic and Statistical Analyses Division, ERS, were asked to review the historical relationships, then project a percentage or share of the national production requirements that the Ohio Basin could be expected to produce, considering the prospective shifts in producing regions.

For most commodities the stability of production trends over the last 20 years suggest no major changes or adjustments. For individual commodities the projected needs may vary; but this is related more to expected changes in per capita consumption rates than to regional shifts in production. The 2010 estimates are merely extensions of the 1980 projections since information available was inadequate to suggest apportionment of national requirements beyond that date.

While the projected allocations are nearly the same as current levels, overall, the Ohio Basin will be producing a slightly smaller share of most all agricultural products (Table 9). Pork, turkeys, fruits, vegetables and dry beans are the exception. The productive capacity and growth of other producing regions explain these minor shifts.

Table 9. Current and Projected Share of United States Output Originating in the Ohio River Basin Region, 1959-61 and Projected 1980

Commodity	Percent of U. S. Production 1959-61	1980
Beef and veal	7.7	6.5
Lamb and mutton	8.4	7.5
Pork	16.9	17.5
Chickens	4.1	2.0
Turkey	9.6	10.0
Milk	13.1	13.0
Eggs	11.7	10.0
Wheat	9.9	8.0
Rye	10.6	8.0
Sugar	8.6	7.5
Soybeans	20.0	18.0
Fruits, noncitrus	8.6	9.5
Vegetables	8.8	9.0
Potatoes	4.9	4.0
Dry beans	35.0	42.0
Sweet potatoes	.9	.5

Source: Economic Framework Section, River Basin and Watershed Branch, RDED, ERS, USDA.

Basin Production Requirements

Even with a slight decline in the Nation's share of agricultural production, quite a large increase in agricultural production will be required in 1980 and 2010 (Table 10). The important variables in determining the product requirements are the per capita rates and population levels. Beef, chickens, turkeys, vegetables and soybeans production will involve better than two-fold increases by 2010. By 1980, product requirements are not expected to increase significantly over present levels except in the care of turkeys and soybeans. For some products, the requirement is expected to be slightly less.[1/]

Assumptions and Limitations

There are inherent limitations in any regionalization of projected requirements for products to be sold on a national market. The estimates are based on the most relevant information available at this time. The projections were developed on the assumption that they would be useful as guides in the development of a framework plan for resource use and development.

Even though the per capita consumption rates, import-export balances, and regional allocations may want for precision and accuracy, the projections do provide an internally consistent, aggregative set of estimates which should (1) aid in the resolution of potential

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[1/] For a discussion of the current agricultural production in the Ohio Basin see the report prepared by the Economic Research Service entitled "The Present Agricultural Economy of the Ohio River Basin," RDED, ERS, March 1964. For the current and projected national requirements refer to Appendix Table 1.

Table 10. Production of Agricultural Products, Ohio River Basin, 1959-61 and Projected 1980 and 2010

Commodity	Unit	1959-61	Production Requirement Index 1980	Production Requirement Index 2010
			(1959-61 = 100)	
Wheat	Bushels	67,281,000	100	125
Oats	Bushels	74,783,000	138	176
Sorghum	Bushels	1,847,000	96	120
Corn	Bushels	570,747,000	157	194
Barley	Bushels	7,396,000	100	131
Rye	Bushels	1,855,000	99	145
Sheep	Lbs.	137,000,000	93	145
Cattle & Calves	Mil. Lbs.	1,962	148	234
Hogs	Mil. Lbs.	3,168	120	186
Farm Chickens	Mil. Lbs.	732	144	238
Broilers	Mil. Lbs.	431.7	104	173
Turkeys	Mil. Lbs.	105.2	208	320
Eggs	Mil. Eggs	5,591	96	148
Milk	Mil. Lbs.	11,185	118	180
Tobacco	000 Lbs.	454,402	136	194
Cotton	000 Bales	2.5	112	168
Vegetables	000 Cwt.	16,436	138	213
Potatoes	000 Cwt.	5,440	92	141
Sweet Potatoes	000 Cwt.	229	74	114
Soybeans	000 Bu.	107,098	203	284
Noncitrus Fruit	000 Tons	346	77	130
Sugar Beets	000 Tons	8.8	28	58

Source: Economic Framework Section, River Basin and Watershed Branch, Resource Development Economics Division, ERS, USDA.

conflicts between competitive resource uses, and (2) provide a partial basis for defining the prospective agricultural need for land and water resource development.

The assumptions in this study are identical with those used in Appendix B of the Ohio report.[1/] Further, the assumptions in this study are consistent with the National Economic Projections developed by the Ad Hoc Water Resources Council in 1963.[2/]

[1/] Op. cit., Appendix B, "Projective Economic Study of the Ohio Basin."

[2/] "National Economic Growth Projections, 1980, 2000, 2020," prepared by the Economic Task Group of the Ad Hoc Water Resource Council Staff, 1963.

PRESENT AND EXPECTED AGRICULTURAL PRODUCTION PATTERNS

The purpose of this section is to present the results of the study outlined heretofore. A discussion of the incorporation of existing production trends in the 1980 projections also follows.

Production and Farm Input Projections

At first glance the land resources of the Basin appear to be definitely under-utilized. Half of the total cropland and pasture acreage is either idle or in permanent pasture (Figure 11). However, this half of the acreage is generally less productive and not well adapted to crop production in its present state. On the other half, feed crops (corn, oats, and barley) are the most important of the major crop groups, accounting for nearly one-fourth of all cropland and pasture. Food crops (wheat, soybeans, dry field beans and potatoes) make up about one-eighth of the total.

Food crop acreage is concentrated in the Wabash and White sub-basins (Appendix Table 2). They contain almost two-thirds of the total acreage of these crops, while making up only one-third of the acres available for crop and pasture production. Much of the food crop acreage is in soybeans, a crop that is gradually displacing small grains and forages on many farms. Feed crops (corn, oats and barley) also are important in the Wabash and White; the Wabash Sub-basin alone accounts for 32 percent of the Basin total.

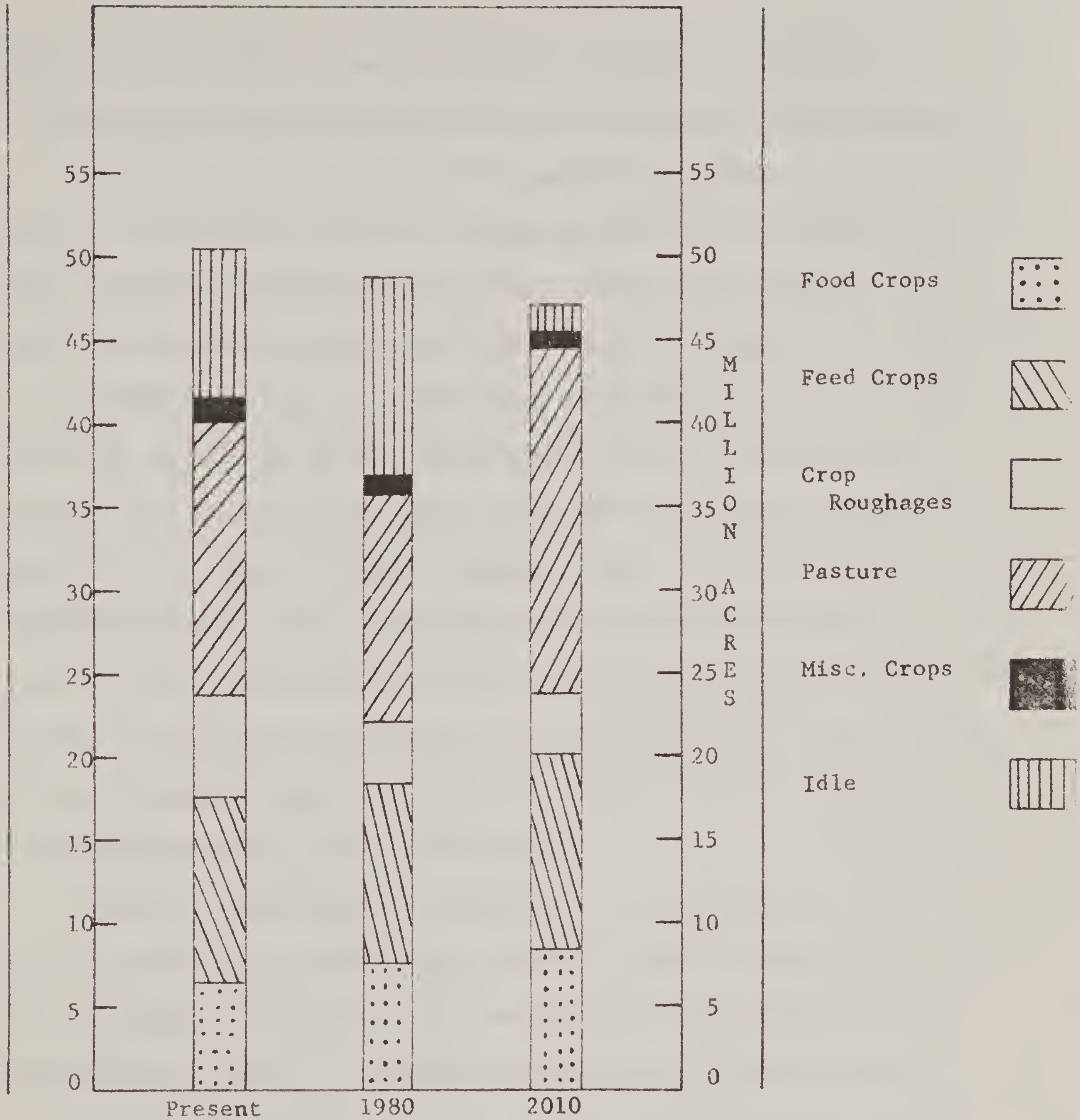


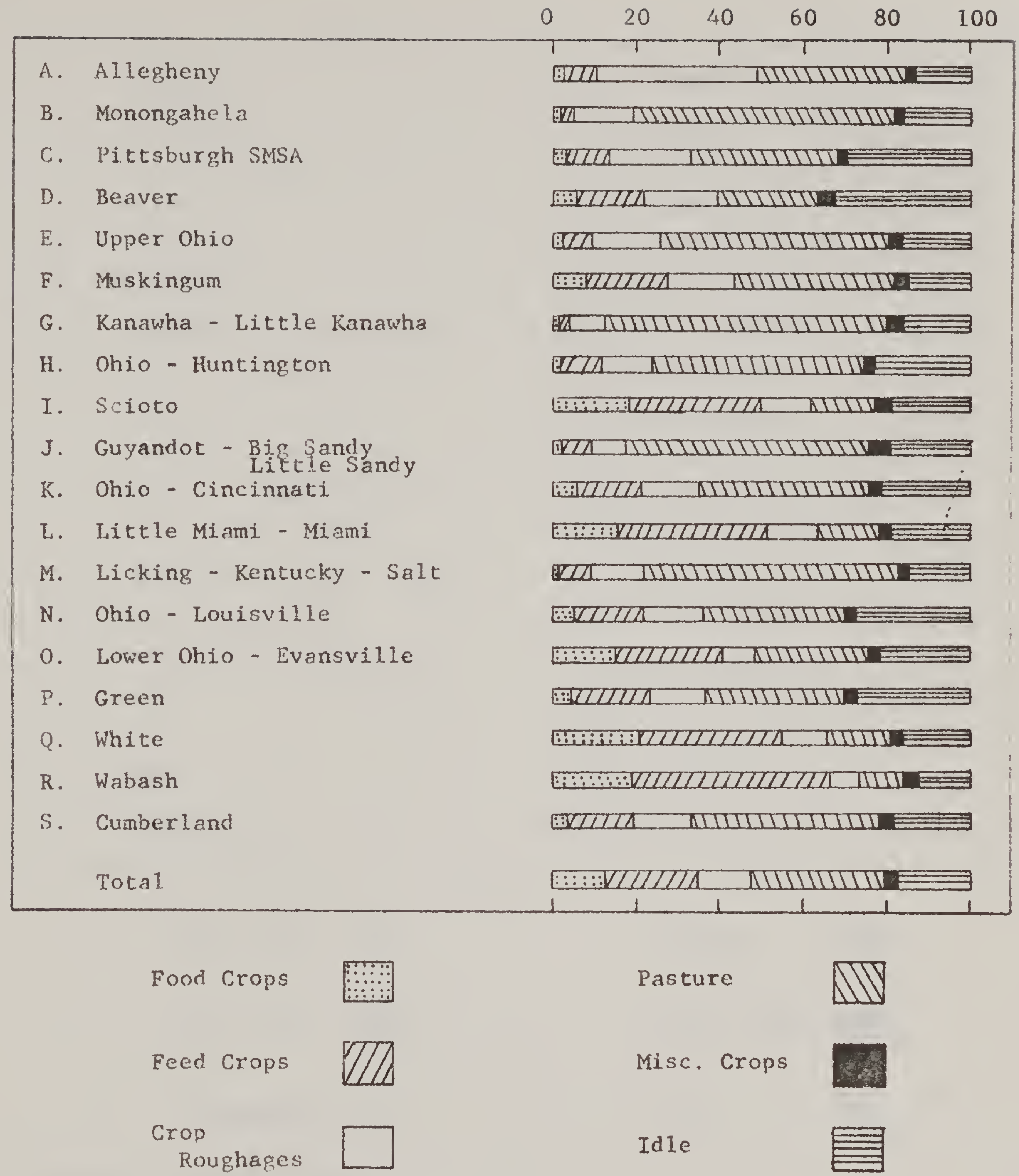
FIGURE 11. USE OF CROPLAND AND PASTURE ACREAGE, PRESENT AND PROJECTED 1980 and 2010, OHIO RIVER BASIN

Crop roughages (hay, silage and cropland pasture) and permanent pasture are distributed more uniformly among the various sub-basins.

Less land will be available for production in 1980, as almost a million acres will be taken up by nonfarm uses which are associated with a growing population (see page 33). About half of this acreage is in the Miami, White and Wabash sub-basins. The loss in area will be compensated by gains in productivity, however, so less land will be needed to produce the Basin's projected share of farm products. In fact, the amount of idle land is expected to be about one-third higher in 1980 than at present (Appendix Tables 2 and 3). Changes in the proportion of idle land vary widely among the sub-basins. Six such areas show decreases in idle land in 1980 while in seven others unused land is projected at more than double the current level (compare Figures 12 and 13). Most of the projected increases are in the northern and eastern sub-basins.

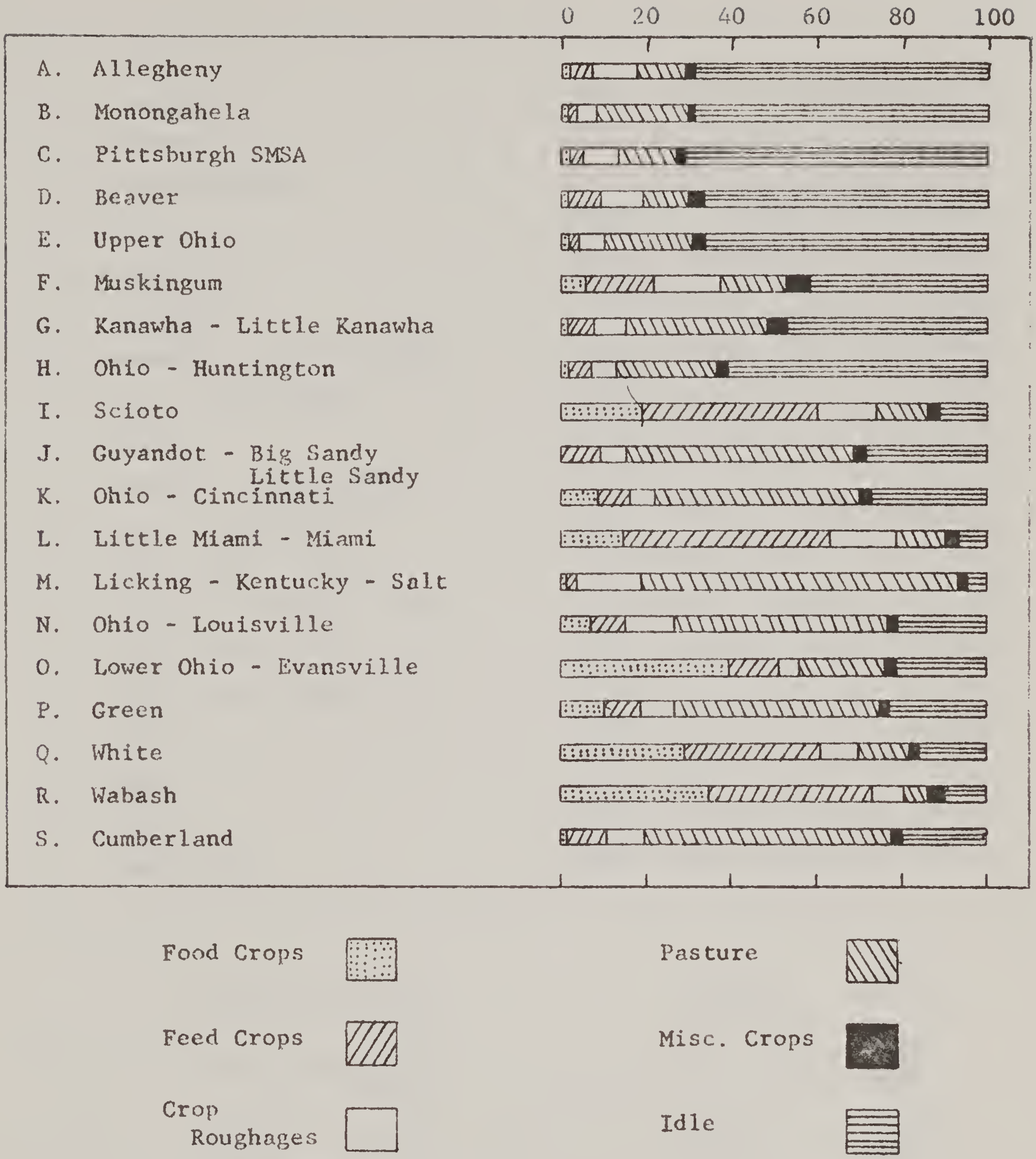
Food crop acreage may be expected to rise 26 percent by 1980 but this growth will be more than offset by losses in feed crops, crop roughages, and miscellaneous crops (fruits, vegetables and miscellaneous grains). The net result will be a slight reduction in total acreage devoted to crop production. Pasture acreage also will decline about 15 percent. Four of the sub-basins can expect decreases in all of the major crop and pasture groups, while the others show various combinations of gains and losses.

Changes in land use between 1980 and 2010 involve a general shift out of the idle category and into pasture (Figure 14).



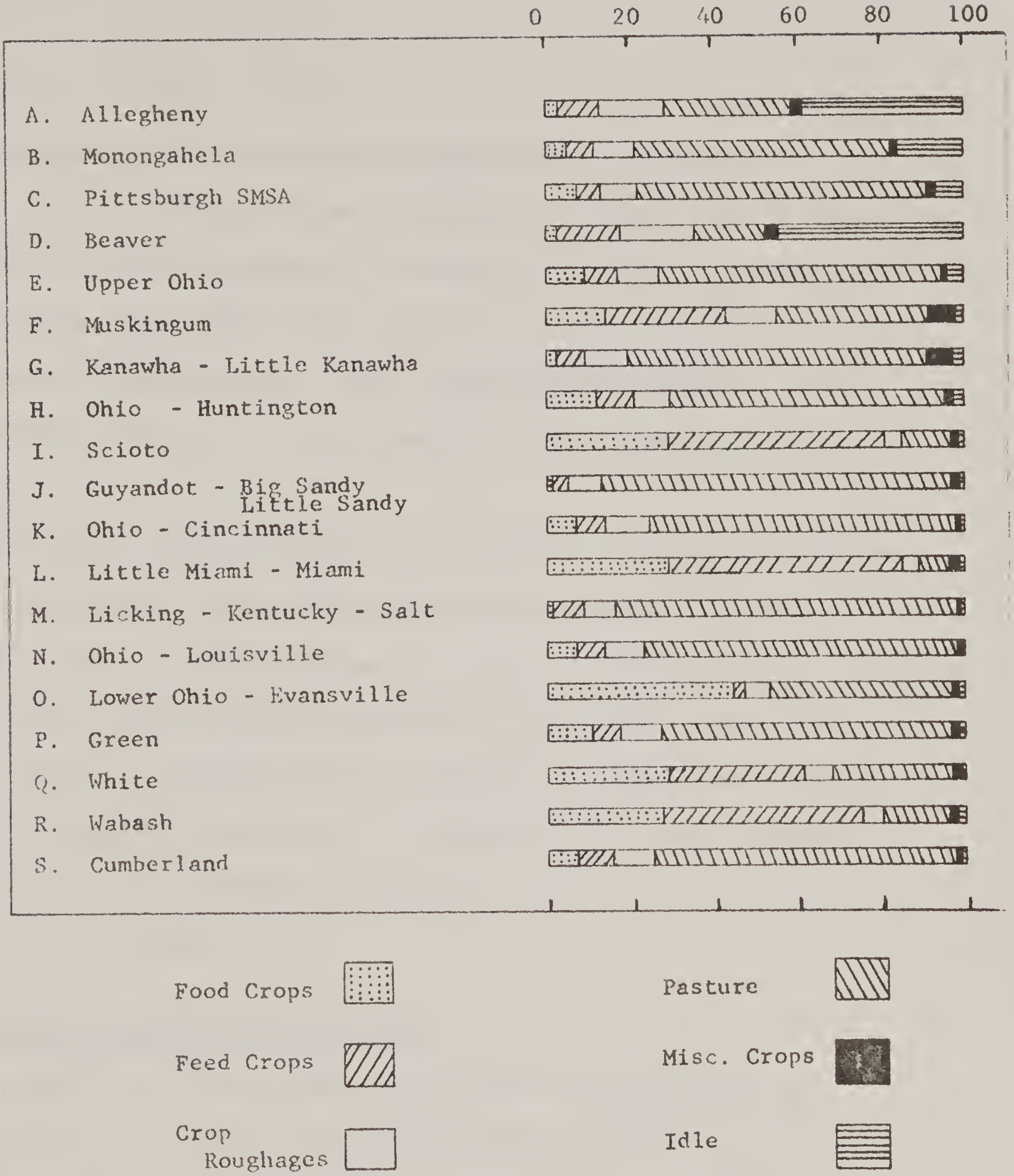
Source: Appendix Table 2

FIGURE 12. PERCENT OF CROPLAND AND PASTURE ACREAGE IN MAJOR CROP AND PASTURE GROUPS BY SUB-BASINS, OHIO RIVER BASIN, PRESENT TIME PERIOD



Source: Appendix Table 3

FIGURE 13. PERCENT OF CROPLAND AND PASTURE ACREAGE IN MAJOR CROP AND PASTURE GROUPS BY SUB-BASINS, OHIO RIVER BASIN, 1980



Source: Appendix Table 4

FIGURE 14. PERCENT OF CROPLAND AND PASTURE ACREAGE IN MAJOR CROP AND PASTURE GROUPS BY SUB-BASINS, OHIO RIVER BASIN, 2010

Increases in acreages of food and feed crops as well as crop roughages are expected, but such changes are expected to be small relative to the 52 percent average increase in pasture. In nearly half of the sub-basins pasture acreage will be doubled or tripled and decreases will occur in only three. Idle land will all but disappear in the Guyandotte, Ohio-Louisville, Green and Cumberland sub-basins, but substantial acreages will remain unused in the eastern part of the Basin.

The total acreage of land in crops in 2010 will be only slightly above the present level, while pasture will be nearly 30 percent higher. Thus, the total land used in crop and pasture production in 2010 will be about 12 percent higher than the present. Feed crops will continue to dominate the crop acreage even though their acreage increases by only one percent. An increase of more than one-third will occur in land producing food crops. Soybeans will account for much of this increase.

Crop and Pasture Production Patterns

Changes in crop and pasture production in the Basin and its sub-areas are the result of changes in yields as well as in acreages. Production of food crops (in tons of product) is expected to increase 81 percent by 1980, while acreage will be only 26 percent higher (Table 11). Feed crop production will rise 46 percent even though acreage will be less than at present. The larger increase in food crops is mainly due to the rapid increase in soybean production in response to a doubling demand between 1959-61 and 1980 (Table 10).

[illegible]

[illegible]

[illegible]

[illegible]

Table 11. Production of Food and Feed Crops and Crop Roughages by Sub-basin, Ohio River Basin, Present and Projected 1980 and 2010

Sub-basin 1/		Food Crops	
	Present	1980	2010
	-----------	Tons of Product	-----------
A Allegheny	26,483	25,301	65,874
B Monongahela	35,021	4,323	92,021
C Pittsburgh SMSA	12,174	13,167	63,867
D Beaver	27,036	14,079	22,837
E Upper Ohio	16,130	15,919	158,188
F Muskingum	151,290	153,329	528,381
G Kanawha - Little Kanawha	9,589	6,272	73,342
H Ohio - Huntington	8,037	9,446	191,051
I Scioto	393,828	587,014	1,098,280
J Guyandotte - Big Sandy Little Sandy	156	59	1,798
K Ohio - Cincinnati	46,887	121,698	122,626
L Little Miami - Miami	350,150	486,430	1,182,495
M Licking, Kentucky, Salt	12,446	7,059	27,451
N Ohio - Louisville	27,923	76,496	93,821
O Lower Ohio - Evansville	321,413	1,160,423	1,674,181
P Green	62,135	227,954	340,760
Q White	893,865	1,730,109	2,074,092
R Wabash	2,159,036	3,655,728	3,546,065
S Cumberland	65,110	53,724	361,397
TOTAL	4,618,709	8,348,530	11,718.527

Table Continued--

Table 11. Production of Food and Feed Crops and Crop Roughages by Sub-basin, Ohio River Basin, Present and Projected 1980 and 2010 (CONT.)

Sub-basin 1/	Feed Crops Present	Feed Crops 1980	Feed Crops 2010
	Tons of Product		
A Allegheny	218,175	212,863	348,496
B Monongahela	54,804	43,458	115,097
C Pittsburgh SMSA	81,488	45,077	56,874
D Beaver	169,032	117,861	216,315
E Upper Ohio	119,766	82,951	134,155
F Muskingum	762,864	850,811	1,734,382
G Kanawha - Little Kanawha	90,429	258,528	263,573
H Ohio - Huntington	170,090	109,879	130,503
I Scioto	1,456,552	2,715,729	4,489,477
J Guyandotte - Big Sandy Little Sandy	34,223	58,562	34,047
K Ohio - Cincinnati	332,235	255,576	201,260
L Little Miami - Miami	1,792,757	3,501,048	5,142,636
M Licking, Kentucky, Salt	397,472	290,709	399,593
N Ohio - Louisville	222,743	204,940	100,859
O Lower Ohio - Evansville	900,705	795,852	102,119
P Green	553,086	615,649	212,174
Q White	2,982,008	4,018,673	5,360,843
R Wabash	5,933,134	9,860,456	14,277,615
S Cumberland	699,272	746,966	380,179
TOTAL	16,970,835	24,785,588	33,700,197

Table Continued--

Table 11. Production of Food and Feed Crops and Crop Roughages by Sub-basin, Ohio River Basin, Present and Projected 1980 and 2010 (CONT.)

Sub-basin 1/	Crop Roughages		
	Present	1980	2010
	----------Tons of Product----------		
A Allegheny	840,611	1,251,768	1,312,476
B Monongahela	356,248	314,483	891,588
C Pittsburgh SMSA	326,031	430,318	428,072
D Beaver	390,441	389,126	499,366
E Upper Ohio	385,211	436,855	746,133
F Muskingum	1,093,457	1,389,362	1,437,493
G Kanawha - Little Kanawha	589,195	625,441	1,336,437
H Ohio - Huntington	266,559	304,762	634,979
I Scioto	794,116	1,412,214	631,821
J Guyandotte - Big Sandy Little Sandy	34,465	34,715	180,629
K Ohio - Cincinnati	358,251	392,957	886,960
L Little Miami - Miami	938,685	1,768,150	601,699
M Licking, Kentucky, Salt	914,639	1,064,491	1,474,794
N Ohio - Louisville	295,077	540,305	517,469
O Lower Ohio - Evansville	407,345	465,098	997,251
P Green	574,854	653,633	1,208,545
Q White	1,184,851	1,867,278	1,996,722
R Wabash	1,639,281	2,525,319	2,753,403
S Cumberland	822,873	999,075	1,636,750
TOTAL	12,212,190	16,865,350	20,172,587

Source: 1959 Census of Agriculture

1/ Sub-basin definition identical with that used in Appendix B of the Ohio Basin Comprehensive Survey Report except that Cattaraugus and Chantangua counties of New York State are added to the Allegheny Sub-basin.

Production of food crops is projected to decline in 8 sub-basins most of which are in the eastern or southern portion of the Basin. The largest increases are expected in the Lower Ohio - Evansville and Green sub-basins where production will be more than triple the present level. Gains and losses in feed crops are mixed among the sub-basins.

Changes in production of crop roughages to 1980 are smaller than is food or feed crops. Increases are projected for all sub-basins except the Monongahela and Beaver, with the greatest percentage growth in the Scioto, Miami and Ohio-Louisville sub-basins.

Production rises are expected in all the major crop groups between 1980 and 2010, but the percentage changes are smaller than from the present to 1980. The chief reason for the slower rate of growth is the leveling off of crop yield increases between 1980 and 2010. Annual yield increases in this period are projected at roughly two-thirds of the 1960-80 annual figures. The net result is that production of food crops in 2010 will be about double the present production--food crops will be two and one-half times the present level and crop roughages about two-thirds above the present.

The tonnage of crop production in the projection years by sub-basins is important information in the analysis of transportation problems. Due to yield increases and changing cropping patterns among sub-basins, production distribution and acreage-use distribution vary somewhat. Minor crop production is not included in the tonnage

figures presented. While these crops are high-valued, they do not represent sizeable quantities for transport.

Comparison of Existing Trends With Projected Production

An initial run of the projection model for 1980 provided cropping patterns among sub-basins that appeared inconsistent with trends in production patterns as found in the Census of Agriculture. The efficiency aspect of the model allowed concentrations of production and eliminated production in some sub-basins. The direction of change was consistent with trend information. Although agricultural production is moving to areas of efficient production, the shifts probably would not be as rapid as the basic projection model implied. Consequently, trends in production as reported by the Bureau of Census and the Statistical Reporting Service were analyzed to identify reasonable bounds on production pattern changes by 1980.

An interpretation of trends indicates that at least half of the acreage now devoted to the major crops would be utilized for these crops in 1980. Thus, a minimum acreage restraint was placed on each Land Resource Area for the major food, feed and roughage crop for the 1980 computer run. The 1980 distributions shown herein reflect, in part, a continuation of past trends as well as an emphasis on farmers' continued efficient use of their land resources.

The projection year 2010 represents a time span into the future during which new generations of resource owners and managers will be producing the needed agricultural products. For the 2010 projection,

the assumption is that capital flows, farm consolidation and other management techniques will be sufficient to allow the efficiency aspect of the model to fully operate for the 2010 projection. The results of the 2010 computer run indicate a slight reversal of current trends in production among sub-basins (see Appendix Tables 5, 6 and 7). The expected population pressure by 2010 for agricultural products is such that very little agricultural land is projected to be idle. Idle lands that are brought into use are expected to be employed efficiently. Even so, sub-basins previously losing out in the production of feed and food crops, gain in relative as well as absolute production by 2010.

Fertilizer Use

Fertilizer applications have been increasing for many years in the Basin, as in the entire Nation. This trend is assumed to continue into the projection years. Indeed, the achievement of projected yield increases is based to a considerable extent on heavier applications of fertilizer on an increasing proportion of crop and pasture acreage. Total tonnage of nitrogen (actual N) is expected to be double its current level in 1980, while P_2O_5 and K_2O are likely to be nearly 50 percent higher (Table 12). Between 1980 and 2010, applications will continue to increase although the annual rate of increase will be less than during the current-to-1980 period. The tonnage of N in 2010 will be more than two and one-half times as high as at present, and the percentage increases in P_2O_5 and K_2O will be

Table 12. Fertilizer Use on Crops and Pasture, by Sub-basins, Ohio River Basin, Present and Projected 1980 and 2010

Sub-basin	Present			Projected 1980			Projected 2010		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	-----000 Tons------			-----000 Tons------			-------000 Tons--------		
A Allegheny	5.0	8.6	8.0	7.6	11.6	6.3	6.7	21.3	21.8
B Monongahela	2.1	4.9	3.9	1.9	6.3	6.9	5.0	22.4	23.1
C Pittsburgh SMSA	2.1	3.7	3.5	2.0	3.6	4.6	2.4	11.1	11.5
D Beaver	3.5	6.8	6.5	3.6	5.5	5.6	4.2	8.2	8.2
E Upper Ohio	2.8	6.7	5.5	2.9	6.2	7.0	5.2	21.0	21.1
F Muskingum	11.3	25.6	23.0	18.4	30.8	31.5	35.0	44.5	41.4
G Kanawha - Little Kanawha	4.3	8.9	7.8	10.2	18.9	19.7	7.5	42.6	43.9
H Ohio- Huntington	2.6	6.7	5.3	4.0	6.9	7.4	5.5	21.4	20.7
I Scioto	22.8	36.3	29.5	57.7	48.2	48.2	98.8	72.1	71.7
J Guyandotte - Big Sandy Little Sandy	0.8	1.8	1.6	1.1	3.5	3.6	1.0	6.3	6.9
K Ohio - Cincinnati	8.3	12.6	13.1	6.7	14.0	14.7	8.8	23.8	23.8
L Little Miami - Miami	25.8	38.9	35.1	74.4	55.7	55.7	112.2	77.5	77.9
M Licking, Kentucky, Salt	13.0	18.3	22.5	7.1	40.8	43.6	10.8	62.5	63.4
N Ohio - Louisville	5.4	8.0	7.9	5.5	12.8	14.9	3.5	19.4	20.2
O Lower Ohio - Evansville	13.9	21.4	23.7	19.6	32.8	33.7	5.6	55.7	57.9
P Green	13.0	22.2	20.9	16.0	32.3	35.6	6.0	53.0	56.9
Q White	41.9	57.9	63.4	88.8	82.8	84.8	124.0	123.1	125.0
R Wabash	75.8	105.7	125.6	203.7	171.5	168.6	310.6	249.0	243.8
S Cumberland	17.9	26.9	25.7	18.0	45.7	48.5	11.4	80.9	85.5
TOTAL	272.2	422.0	432.5	549.3	629.8	640.9	764.3	1,015.7	1,024.8

Source: Present estimate developed from "Commercial Fertilizer Used on Crops and Pasture in the United States 1959 estimates," Statistical Bulletin No. 348, July 1964.

slightly less. Wide variations are expected to occur among the sub-basins in the rate of change in fertilizer use over time, mainly because of differences in the crops produced.

The projected fertilizer applications will be sufficient to maintain soil productivity at the relatively high crop yield levels of the projection years. Actual fertilizer applications may be less in areas of high livestock production, where manure may be used to supply plant food nutrients. However, the effect of such substitution on total fertilizer consumption in the Basin is not expected to be significant.

Production Costs for Crops

Total costs of production for feed, food and hay crops in the Basin are expected to be 1.05 billion dollars in 1980 and 1.35 billion in 2010, a rise of 28 percent. Comparable data on current production costs are not available. Production costs were based on current input price levels, therefore changes in these costs reflect only changes in physical inputs such as increasing levels of fertilizer application and higher machinery costs for harvesting the larger yields of crops in the projection years. They are offset to some extent by decreasing physical labor inputs. As would be expected from their large acreage, feed grains account for more than half of total costs in 1980 and 2010.

Critical Assumptions and Limitations

Assumptions affecting crop, pasture and livestock production in the Basin as a whole have been mentioned previously. These assumptions on rate of increase in crop yields, livestock feeding efficiencies, production costs and demand factors also apply in estimates of resource use and production among the sub-basins. Differences between the projected and actual crop yields in the various sub-basins, for example, could result in errors in projected shifts of production from one sub-basin to another. Similarly, differential changes in livestock feeding efficiencies could affect allocation of livestock production among the sub-basins.

Gains in labor efficiency were assumed to apply uniformly throughout the Basin for each crop and livestock enterprise. Differences in gains among the sub-basins could change the allocation of both crops and livestock. Such gains likely will tend toward greater uniformity with the passage of time. Motivation of farmers in the direction of general production efficiency and profitable use of resources also was assumed to be uniform among the sub-basins. In terms of the model used in allocating production, farmers currently are not using resources in the most efficient manner, and therefore considerable gains in efficiency are possible. Differences among the sub-basins in the rate of reorganization of resources toward profitable production would change production patterns considerably. Here again, it is believed that farmers will tend to become more nearly

uniform in managerial ability and will react more uniformly to economic stimuli.

Rural Farm Population and Employment

Both farm population and employment in agriculture are expected to decrease to a fraction of the current figures by 2010. Farm sizes likely will continue to increase with mechanization and many small farmers will find better employment opportunities in non-farm work.

Basin Farm Population

Population projections were developed on the basis of trends in numbers of farms by economic classes and on numbers of persons per farm household. The ratio of part-retirement farms to other farms was assumed to remain at the 1960 level throughout the Basin. These farms were assumed to have a population of two people per farm and to remain at that level in 1980 and 2010. Population per household on the remaining farms was assumed to vary by sub-basins and to decrease gradually, approaching non-farm population per household by 2010. Population was assumed to decline to 3.47 per farm household in 1980 and 3.33 in 2010, compared with 3.40 and 3.28 for all households in the Basin.

The definition of farm population in this report is consistent with the 1960 Census of Population. The Census definition includes all persons living on tracts of 10 or more acres with farm product sales of $50 or more, or on tracts of less than 10 acres if sales

amount to $250 or more. This definition has certain limitations. A few people who live on farms were excluded who live within the boundaries of incorporated places of 2,500 or more population, and also those who live in urban places but work on farms. On the other hand, the definition includes people who are classified as farmers but also have full- or part-time work off the farm. Multiple job holding can be important in some areas of the Basin in terms of numbers. While the definition allows for undercounting in urban places under 2,500, multiple job holding is considered more significant. The net affect may be an overstatement of the number of people who contribute to agricultural production.

Farm population is expected to decline 35 percent from the present to 1980 (Table 13). As would be expected, the smallest decreases are projected for the more productive agricultural areas, such as the Muskingum, Scioto, Wabash, and White. Much larger percentage declines are expected in such areas as the Guyandotte, Licking-Kentucky-Salt, and Cumberland which are less productive, and in the Pittsburgh and Cincinnati areas, where agriculture is gradually being displaced by urban expansion.

Population is expected to continue its decline from 1980 to 2010, with less variation among areas than in the 1960-1980 period. The number of people on farms in 2010 will be only 38 percent of the current number. In a few sub-basins there will be less than one-fourth as many farm people in 2010 as in 1960.

Table 13. Farm Population by Sub-basins: Ohio River Basin, Present and Projected, 1980 and 2010

	Sub-basin	Thousands of Persons			Percent Changes	
		Present[1]	1980	2010	Present to 1980	Present to 2010
A	Allegheny	50.2	32.7	26.5	-34.9	-47.2
B	Monongahela	38.2	27.7	19.0	-27.5	-50.3
C	Pittsburgh SMSA	20.2	10.9	6.8	-46.0	-66.3
D	Beaver	29.8	20.9	12.8	-29.9	-57.0
E	Upper Ohio	39.6	22.0	17.6	-44.4	-55.6
F	Muskingum	95.9	80.7	42.3	-15.8	-55.9
G	Kanawha - Little Kanawha	100.1	62.5	42.7	-37.6	-57.3
H	Ohio - Huntington	49.7	22.9	19.5	-53.9	-60.8
I	Scioto	76.6	67.6	44.0	-11.7	-42.6
J	Guyandotte -- Big Sandy Little Sandy	31.8	10.6	9.1	-66.7	-71.4
K	Ohio - Cincinnati	60.2	28.3	19.0	-53.0	-68.4
L	Little Miami - Miami	100.4	93.6	45.3	- 6.8	-54.9
M	Licking, Kentucky, Salt	183.9	73.8	39.6	-59.9	-78.5
N	Ohio - Louisville	49.1	32.8	15.4	-33.2	-68.6
O	Lower Ohio - Evansville	73.9	49.6	26.0	-32.9	-64.8
P	Green	130.9	59.3	37.6	-54.7	-71.3
Q	White	168.6	139.0	66.3	-17.6	-60.8
R	Wabash	230.8	212.8	120.1	- 7.8	-48.0
S	Cumberland	230.1	91.5	56.7	-60.2	-75.4
	TOTAL	1,760.0	1,139.2	666.3	-35.3	-62.1

[1] 1960 Census of Population

Basin Farm Employment

Farm employment was estimated from labor requirements for producing the quantities of farm products projected for 1980 and 2010. Labor requirements per unit of product were assumed to decline drastically from current levels to the projection years, in accordance with past trends. The number of hours per man year of labor were assumed to drop from 2,232 in 1959-61 to 1,910 in 1980 and 1,650 in 2010, in line with projections made by the Ad Hoc Water Resources Council Staff.[1/] The present relationship between labor requirements and employment was assumed to continue in the projection years.

Employment estimates are more nearly in line with the Census of Population concept of employment than with the Census of Agriculture estimates of numbers of farm workers. The Census of Agriculture records the number of workers on farms during the week prior to enumeration and includes seasonal workers who may have been employed only a fraction of the year. The Census of Population classifies workers on the basis of income earned, placing workers in the industry from which they derive the largest income. Employment estimates in this study include all labor used on farms.

Employment is projected to decline by 45 percent from the present to 1980 for the Basin as a whole, with decreases ranging from 16 percent in the Wabash to more than two-thirds in the Ohio-Huntington, Licking-Kentucky-Salt and Cumberland (Table 14). The average rate

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1/ Op. cit., "National Economic Growth Projections, 1980, 2000, 2020," July 1963.

Table 14. Employment in Agriculture, by Sub-basins, Ohio River Basin, Present and Projected 1980 and 2010

Sub-basin	Thousands of Persons			Percent Changes	
	Present[1]	1980	2010	Present to 1980	Present to 2010
A Allegheny	12.5	7.7	6.2	-38.4	-50.4
B Monongahela	8.1	4.7	3.8	-42.0	-53.1
C Pittsburgh SMSA	7.5	2.8	1.9	-62.7	-74.7
D Beaver	6.1	3.6	2.4	-41.0	-60.7
E Upper Ohio	8.9	3.8	3.3	-57.3	-62.9
F Muskingum	22.8	17.3	9.6	-24.1	-57.9
G Kanawha - Little Kanawha	18.7	9.8	7.6	-47.6	-59.4
H Ohio - Huntington	11.0	3.5	3.2	-68.2	-70.9
I Scioto	21.6	14.3	8.7	-33.8	-59.7
J Guyandotte - Big Sandy Little Sandy	3.8	1.3	1.2	-65.8	-68.4
K Ohio - Cincinnati	15.5	6.0	4.4	-61.3	-71.6
L Little Miami - Miami	28.1	19.8	9.2	-29.5	-67.3
M Licking, Kentucky, Salt	46.6	15.3	8.9	-67.2	-80.9
N Ohio - Louisville	11.9	6.1	3.3	-48.7	-72.3
O Lower Ohio - Evansville	19.4	9.7	5.8	-50.0	-70.1
P Green	30.1	11.9	7.2	-60.5	-76.1
Q White	35.5	28.4	16.2	-20.0	-54.4
R Wabash	59.0	49.3	30.0	-16.4	-49.2
S Cumberland	52.9	16.6	10.2	-68.6	-80.7
TOTAL	420.0	231.9	143.1	-44.8	-65.9

[1] 1960 Census of Population

of decline is expected to be slower between 1980 and 2010 in most of the sub-basins but will be more rapid in the Muskingum, Miami, White and Wabash. By 2010, employment will be a little more than one-third of the present level.

Assumptions and Limitations

Projections of farm population depend upon estimates of farm employment and family size. While size of family is an important factor, it is not so critical as farm employment. Employment figures are expected to change more rapidly than marriage and birth rates which affect family size. Any deviation from the current and past trend of continued farm mechanization, attractive non-farm employment opportunities, and increasing farm size would affect employment estimates. If labor requirements decrease at a slower rate than those projected here, the actual employment would be greater than the projected employment. Conversely, increases in migration out of agriculture could occur if estimates of labor requirements in the projection years are higher than the actual requirements.

Comparability of Results With the A. D. Little Study

In the development of their projections for the Ohio Basin, the A. D. Little Company developed output and employment estimates for agriculture for the Basin and sub-basins. These estimates were based primarily on historical relationships. The A. D. Little methodology involved the projections of all economic output for the Ohio Basin. The output was then allocated to the various sectors such as

agriculture, construction, textile mill products, electrical machinery, etc. based on updated 1947 shares. The sub-basin estimates were developed by extrapolating historical trends in sub-basin output.

The ERS analysis, as outlined in this report, considers the relative productivity of the agricultural resource in the various sub-basins and examines potential changes in aggregate demand which influence the use of the agricultural resources, hence output and employment. Ideally the in-depth analysis of the primary sectors in the region should be done first. But funding and timing of studies did not permit this kind of sequencing. Accordingly, comparisons are made in this report to determine potential differences in output and employment by sub-basins.

Agricultural Output Comparison

The distribution of agricultural output or income among sub-basins from the two studies indicate similar general patterns of output. But sufficient differences occur to warrant discussion.

According to the ERS analysis the sub-basins of the Ohio with the most productive agricultural resource base have significantly larger shares of agricultural output (Table 15). The Wabash, White, Scioto and Miami are examples of sub-basins where agricultural output tends to concentrate. For instance, the distributions for the Wabash Sub-basin reflect a two-fold difference, amounting to as much as $75 million in agricultural output. On the other hand, several of the sub-basins with less productive soils show smaller shares.

Table 15. Comparison of Agricultural Income Estimates, A. D. Little and ERS Analyses

Sub-basin	1980 Projections ADLD 1/	1980 Projections ERS	2010 Projections ADLD 1/	2010 Projections ERS
	--------Percent of Basin Total-------			
A Allegheny	2.7	2.2	2.6	2.7
B Monongahela	1.7	1.0	1.4	1.7
C Pittsburgh SMSA	1.6	.8	1.6	.8
D Beaver	1.2	1.1	1.0	1.1
E Upper Ohio	2.2	1.0	2.0	1.5
F Muskingum	5.5	5.1	5.7	5.7
G Kanawha - Little Kanawha	4.4	2.1	3.7	2.9
H Ohio - Huntington	2.5	1.0	2.2	1.5
I Scioto	5.1	8.4	5.3	8.5
J Guyandotte - Big Sandy Little Sandy	.6	.3	.1	.4
K Ohio - Cincinnati	3.8	1.7	3.9	2.0
L Little Miami - Miami	6.7	10.4	7.2	9.5
M Licking, Kentucky, Salt	11.5	3.8	11.7	3.5
N Ohio - Louisville	2.9	2.2	2.9	2.0
O Lower Ohio - Evansville	4.7	5.1	4.7	4.4
P Green	7.5	3.8	7.8	3.4
Q White	8.4	15.2	8.4	14.2
R Wabash	14.1	29.9	14.9	28.6
S Cumberland	12.9	4.9	12.7	5.5
TOTAL	100.0	100.0	100.0	100.0

1/ "Projective Economic Study of the Ohio River Basin" prepared by the Arthur D. Little Company, August 1964, Table II-6, p. 47-67.

Several factors influence these relationships. Perhaps most significant is the level of demand for agricultural products relative to the expected change in production potential in the sub-basins' technology. Agricultural gains in subregions such as the Wabash are expected to improve at a faster rate than requirements for agricultural products. Consequently, agricultural production tends to concentrate in these more efficient areas of production.

The results of the ERS study show considerable increases in idle land in 1980 as a result of the expected demand-gain in technology relationships. Since the poorer lands will be retired by farmers, the sub-areas with large amounts of poorer land would be expected to produce decreasing shares of the Ohio agricultural output. The ERS analysis indicates that these shifts are likely to come about as farmers increase their management skills and become more responsive to the economic conditions in agriculture.

Agricultural Employment Comparison

In general, the relationships for the agricultural employment distribution among the sub-basins hold as was the case for agricultural output. However, some differences occurred which were even counter to the relationships for output. While some of the sub-basins' crop and pasture land is being devoted to lower-valued uses, labor-use intensity remains relatively high. This is particularly the case for sub-basins in the northeastern part of the Basin which have increasing shares of their cropland devoted to roughage production.

By 2010, as cropland in all sub-basins is devoted to higher uses, the employment and output distributions are more nearly alike. The lower-valued output and the relatively high labor-intensive land use would indicate low farm earnings in 1980 for certain sub-basins (Table 16).

Table 16. Comparisons of Agricultural Employment Estimates, A. D. Little and ERS Analyses

Sub-basins	1980 Projections ADLD 1/	1980 Projections ERS	2010 Projections ADLD 1/	2010 Projections ERS
	---------------	------000 Persons	------	---------------
A Allegheny	2.7	3.3	2.6	4.4
B Monongahela	1.7	2.0	1.4	2.7
C Pittsburgh SMSA	1.6	1.2	1.6	1.3
D Beaver	1.2	1.5	1.0	1.7
E Upper Ohio	2.2	1.7	2.0	2.3
F Muskingum	5.5	7.5	5.7	6.7
G Kanawha - Little Kanawha	4.3	4.2	3.7	5.3
H Ohio - Huntington	2.5	1.5	2.2	2.2
I Scioto	5.1	6.2	5.3	6.1
J Guyandotte - Big Sandy Little Sandy	.6	.5	.1	.8
K Ohio - Cincinnati	3.8	2.6	3.9	3.1
L Little Miami - Miami	6.7	8.5	7.2	6.5
M Licking, Kentucky, Salt	11.5	6.6	11.7	6.2
N Ohio - Louisville	2.9	2.6	3.0	2.3
O Lower Ohio - Evansville	4.8	4.2	4.7	4.1
P Green	7.6	5.1	7.8	5.0
Q White	8.4	12.3	8.4	11.2
R Wabash	14.0	21.4	15.0	21.0
S Cumberland	12.9	7.9	12.8	7.1
TOTAL	100.0	100.0	100.0	100.0

1/ "Projective Economic Study of the Ohio River Basin" prepared by the Arthur D. Little Company, August, 1964.

CONCLUSIONS

The Ohio River Basin agricultural resource is expected to be more than adequate in the short-run future (next 10-15 years) to produce its share of the U. S. agricultural product requirements. Of the 50 million acres of crop and pasture land in the Ohio Basin, there are now some 8.5 million acres in private ownership that are idle. Under the assumptions of the framework study and with no further public water resource development the effective demand could be met with nearly 13 million acres of crop and pasture land not in use.[1]

However, by 2010, the results indicate that only 1.5 million acres would not be in use. The conclusion is that the population pressure would be so great that the on-farm agricultural technology development and adoption will not be sufficient to preclude supplies of agricultural commodities to be limited, thereby having an effect on product prices and need for agricultural water resource development.

Implications for Agricultural Irrigation, Drainage, and Flood Protection

The agricultural resource can be improved in many ways. Agricultural research can be emphasized to push for even greater increases in

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[1] The expected reduction of cropland use by farmers in the Ohio region by 4.5 million acres appears consistent with the 51 million acre reduction estimated for the Nation by 1980. See Land and Water Resources: A Policy Guide, USDA, Washington, D. C., May 1962, p. 43.

technology development and food substitutes. Increased emphasis can be placed on extension programs to increase technology adoption. Agricultural land drainage, supplemental irrigation and protection of productive flood plains also are means of improving the land resource and enhancing the long-term productive potential of the Basin.

The fact that 1980 production needs can be met without further public resource development does not mean that water resource development for agricultural purposes in the short run might not be desirable. If economic benefits can be attributed to water developments, then the resource development is in the national interest. However, if cropland is idled because of these measures, a certain opportunity cost occurs which normally is not considered in individual project benefit-cost analyses. Water resource development for agricultural purposes in the long run undoubtedly would be feasible. In other words, water resource development for agricultural purposes may be feasible in the short run as an efficient way of providing agricultural products and may be necessary in the long run to prevent absolute shortages.

Further Use of ERS Projection Model

The computer model developed for the regional framework analysis provides a consistent basis for identifying agricultural resource development needs. Since the model considers national and regional production requirements and the supply potential in each basin, a

framework exists for evaluating the gains or losses if irrigation, drainage and flood protection for agricultural purposes are included or excluded in the framework plan.

Irrigation and drainage potential studies are underway by the Economic Research Service which will supplement the framework analysis and will be reported at a later date as a supplement to this report. However, these studies will indicate general potential and will not be in sufficient detail for project analysis without further study. Detailed studies will be necessary to determine project feasibility for these purposes in each sub-basin.

Farm Population and Livestock Water Needs

The size of the rural farm population is decreasing. Although members of farm families will increase per capita consumption of water, the aggregate domestic need for water by the farm population is expected to decline. Livestock numbers will be increasing significantly; consequently water requirements for livestock will increase. Much of the rural farm home and livestock water supplies come from ground water, therefore the adequacy of this source must be determined. In some areas, public water resource development may be necessary to serve rural farm needs. Although small rural communities under 2,500 in population are declining, they too may need public water development. Further analysis of livestock production within the Basin is underway and will be reported with the irrigation and drainage potential studies.

Agriculturally Dependent or Related Activities

The projected production of crops and livestock and fertilizer use for the sub-basins and the Basin as a whole indicate many interdependent relationships. In some sub-basins there are sizeable decreases in agricultural land due to urban and industrial build-up. Some of these areas also have fewer grain crops; consequently, the habitat and food source for wildlife diminishes. Further, the increased concentrations of fertilizer may influence the quality of water.

The increased tonnage of products sold or used in the farm production process certainly has implications for the transportation and off-farm storage industries. Expected fertilizer use will require increased supplies of fertilizer materials. While agriculturally dependent industries are not high water-using industries or labor intensive industries, the changes in agricultural production are sufficient among sub-basins in 1980 and 2010 to warrant attention. Further the analysis in this study indicates that the agricultural output and employment distribution among sub-basins is sufficiently different from those developed by the A. D. Little Company, that further analysis of the agriculturally related sectors should be made by participating agencies.

[illegible]

[illegible]

[illegible]

Appendix Table 1. Current and Projected Requirements for Major Farm Products, 1959-61, 1980 and 2010, United States

Commodity	Unit	1959-61	1980	2010
		--------Million Pounds----------		
Beef and Veal	Live Wt.	28,206	47,282	74,670
Lamb and Mutton	Live Wt.	1,658	1,699	2,666
Pork	Live Wt.	20,564	23,930	36,967
Chicken	Live Wt.	7,571	11,349	18,793
Turkey	Live Wt.	1,540	3,398	5,212
Milk	--	121,164	142,835	218,648
		------------Number-------------		
Eggs	--	64,993	75,563	116,395
		----------Thousands------------		
Wheat	Bushels	1,185,533	1,492,366	1,872,750
Rye	Bushels	28,143	33,643	48,571
Rice	Cwt.	52,960	81,090	84,570
Flax	Bushels	28,411	22,500	32,000
Soybeans	Bushels	597,600	1,358,583	1,906,100
Peanuts	Pounds	1,760,000	2,416,000	3,700,000
Sugar Crops				
Sugar Cane	Tons	7,712	17,851	36,021
Sugar Beets	Tons	17,047	33,913	68,453
Dry Beans	Cwt.	18,710	18,960	29,260
Dry Peas	Cwt.	4,010	2,840	4,380
Potatoes	Cwt.	258,230	387,150	596,010
Sweet Potatoes	Cwt.	16,840	16,710	25,780
Vegetables	Cwt.	416,640	579,160	892,650
Fruits, Citrus	Tons	7,723	11,710	17,296
Fruits, Noncitrus	Tons	8,098	11,853	19,965
Tree Nuts	Pounds	307,000	392,000	605,000

Source: Economic Framework Section, River Basin and Watershed Branch, RDED, ERS, USDA.

Appendix Table 2. Use of Cropland and Pastureland by Sub-Areas in the Ohio River Basin, Present Time Period

	Sub-Area	Present Crop and Pasture Acreage	Present Time Period: Food Crops 1/	Feed Crops 2/	Crop Roughages 3/	Pasture	Misc. Crops 4/	Idle 5/
		------	------	------	000 Acres	------	------	------
A	Allegheny 6/	2,064.1	49.1	241.3	711.1	731.6	54.6	276.4
B	Monongahela	1,436.3	8.4	52.2	205.3	907.2	16.1	247.1
C	Pittsburgh SMSA	730.0	16.9	77.6	144.2	260.0	8.6	222.7
D	Beaver	814.0	39.4	135.1	136.8	197.2	34.9	270.6
E	Upper Ohio	1,286.0	24.2	98.1	204.6	710.7	21.5	226.9
F	Muskingum	2,823.1	222.8	534.1	456.2	1,074.0	154.2	381.8
G	Kanawha - Little Kanawha	2,588.2	17.4	74.0	214.0	1,764.1	102.0	416.7
H	Ohio - Huntington	1,224.2	14.8	124.4	148.4	625.5	25.9	285.2
I	Scioto	3,013.6	542.7	956.3	352.9	493.8	64.7	603.2
J	Guyandotte - Big Sandy Little Sandy	373.2	2.5	33.4	29.3	221.7	9.9	76.4
K	Ohio - Cincinnati	1,428.9	80.0	221.0	188.8	600.7	24.9	313.5
L	Little Miami - Miami	3,190.1	469.3	1,147.9	382.0	495.6	65.0	630.3
M	Licking, Kentucky, Salt	3,775.5	22.2	301.5	468.6	2,341.4	60.6	581.2
N	Ohio - Louisville	1,059.4	43.9	183.5	154.0	372.5	18.5	287.0
O	Lower Ohio - Evansville	2,759.4	412.1	699.6	215.7	773.5	53.8	604.7
P	Green	2,616.4	90.7	495.3	350.4	904.5	51.3	724.2
Q	White	5,516.9	1,122.0	1,926.1	529.7	915.1	112.5	911.5
R	Wabash	9,969.1	2,869.0	3,729.3	669.3	1,159.4	228.8	1,313.3
S	Cumberland	3,895.5	92.2	644.6	521.9	1,800.6	82.0	754.2
	TOTAL	50,563.9	6,139.6	11,675.3	6,083.2	16,349.1	1,189.8	9,126.9

Source: "Present Cropland and Pasture Acreage," National Soil and Water Conservation Needs Inventory. Acreage of food crops, feed crops, crop roughages and miscellaneous crops, 1959 Census of Agriculture County Tables. Idle is the residual obtained by subtracting crops and pasture from "Present Crop and Pasture Acreage."

Table Continued--

Appendix Table 2. Use of Cropland and Pastureland by Sub-Areas in the Ohio River Basin, Present Time Period (CONT.)

1/ Includes wheat, soybeans, dry field beans and potatoes.

2/ Corn, oats and barley.

3/ Corn silage, alfalfa mixtures, other hay and cropland pasture.

4/ Fruits, vegetables, miscellaneous small grain.

5/ Includes land planted to crops but not harvested.

6/ Includes Chautaugua and Cattaraugus Counties of New York State.

Appendix Table 3. Use of Cropland and Pastureland by Sub-Areas in the Ohio River Basin, 1980 Projection

Sub-Area	Present Crop and Pasture Acreage	1980 Projected Use of Existing Crop and Pasture Land[1/]						
		Food Crops	Feed Crops	Crop Roughages	Pasture	Misc. Crops	Idle	Urban Areas[2/]
	000 Acres							
A Allegheny	2,064.1	24.6	122.7	212.0	219.2	36.3	1,423.4	25.9
B Monongahela	1,436.3	16.6	82.9	54.9	166.5	14.6	1,091.8	9.0
C Pittsburgh SMSA	730.0	8.7	39.7	31.5	138.8	7.9	484.6	18.8
D Beaver	814.0	13.2	54.6	78.0	107.8	24.2	510.5	25.7
E Upper Ohio	1,286.0	25.6	84.4	64.7	252.0	20.2	820.8	18.3
F Muskingum	2,823.1	172.6	560.9	429.1	398.4	141.4	1,072.7	48.0
G Kanawha - Little Kanawha	2,588.2	14.3	239.8	127.7	831.3	104.4	1,262.1	8.6
H Ohio- Huntington	1,224.2	36.0	90.3	57.9	295.9	24.7	709.4	10.0
I Scioto	3,013.6	454.1	1,335.2	309.9	433.1	59.2	330.1	92.0
J Guyandotte - Big Sandy Little Sandy	373.2	1.1	25.5	23.7	215.9	9.6	97.0	0.4
K Ohio - Cincinnati	1,428.9	241.5	50.6	52.4	680.2	22.5	337.4	44.3
L Little Miami - Miami	3,190.1	505.0	1,514.6	344.6	456.5	59.2	201.4	108.8
M Licking, Kentucky, Salt	3,775.5	67.2	169.2	179.0	3,095.8	56.3	123.6	84.4
N Ohio - Louisville	1,059.4	144.3	70.9	47.5	590.4	17.2	169.7	19.4
O Lower Ohio - Evansville	2,759.4	1,163.3	262.0	142.0	505.3	50.2	629.1	7.5
P Green	2,616.4	413.5	248.1	132.0	1,312.7	48.8	452.4	8.9
Q White	5,516.9	1,335.3	1,657.8	442.1	921.8	103.3	937.6	119.0
R Wabash	9,969.1	2,776.6	3,867.9	656.9	841.9	216.4	1,382.6	226.8
S Cumberland	3,895.5	313.1	349.0	213.0	2,225.3	78.9	683.6	32.6
TOTAL	50,563.9	7,726.6	10,826.1	3,598.6	13,688.8	1,095.3	12,719.8	908.4

1/ See Appendix Table 2 footnotes.

2/ Represents the amount of existing crop and pasture land expected to be diverted to nonagricultural uses between the present time and 1980.

Appendix Table 4. Use of Cropland and Pastureland by Sub-Areas in the Ohio River Basin, 2010 Projections.

Sub-Area	Present Crop and Pasture Acreage	2010 Projected Use of Existing Crop and Pasture Land[1/]						
		Food Crops	Feed Crops	Crop Roughages	Pasture	Misc. Crops	Idle	Urban Areas[2/]
	---000 Acres---							
A Allegheny	2,064.1	47.7	205.8	297.8	617.6	35.0	771.9	88.3
B Monongahela	1,436.3	66.5	95.5	139.4	852.8	14.3	233.1	34.7
C Pittsburgh SMSA	730.0	45.5	39.8	61.6	468.5	7.4	48.4	58.8
D Beaver	814.0	16.3	112.6	132.3	123.0	22.4	325.9	81.5
E Upper Ohio	1,286.0	112.9	93.2	115.3	835.9	19.6	51.5	57.6
F Muskingum	2,823.1	376.3	755.0	337.5	996.3	136.1	65.3	156.6
G Kanawha - Little Kanawha	2,588.2	52.5	192.1	249.4	1,859.3	103.4	96.6	34.9
H Ohio - Huntington	1,224.2	136.5	102.2	113.1	776.5	24.4	37.8	33.7
I Scioto	3,013.6	775.7	1,421.8	112.7	330.7	56.0	46.1	270.6
J Guyandotte - Big Sandy Little Sandy	373.2	1.3	18.1	29.0	311.6	9.3	1.9	2.0
K Ohio - Cincinnati	1,428.9	87.1	94.1	131.5	960.1	21.0	3.8	131.3
L Little Miami - Miami	3,190.1	834.4	1,603.2	97.6	237.0	55.5	46.3	316.1
M Licking, Kentucky, Salt	3,775.5	21.2	271.3	270.3	2,897.8	52.9	9.2	252.8
N Ohio - Louisville	1,059.4	70.4	68.5	93.3	749.1	16.7	3.5	57.9
O Lower Ohio - Evansville	2,759.4	1,203.2	67.0	165.0	1,222.4	50.6	22.6	28.6
P Green	2,616.4	260.7	177.1	247.3	1,841.8	48.7	10.1	30.7
Q White	5,516.9	1,476.4	1,704.3	307.4	1,517.9	99.5	57.5	353.9
R Wabash	9,969.1	2,520.7	4,506.6	395.9	1,547.0	208.9	114.6	675.4
S Cumberland	3,895.5	278.8	298.8	347.5	2,792.6	77.1	5.6	95.1
TOTAL	50,563.9	8,384.1	11,827.0	3,643.9	20,937.9	1,058.8	1,951.7	2,760.5

1/ See Appendix Table 2 footnotes.

2/ Represents the amount of existing crop and pasture land expected to be diverted to nonagricultural uses between the present time and 2010.

Appendix Table 5. Distribution of Food Crop Production, Historical and Projected, Ohio River Basin, 1949-2010

Sub-Area	Tons of Product			
	1949	1959	1980	2010
	----------percent----------			
A Allegheny	4.4	2.3	.3	.6
B Monongahela	.9	.4	.1	.8
C Pittsburgh SMSA	.8	.3	.2	.5
D Beaver	2.2	1.0	.2	.2
E Upper Ohio	1.7	.8	.2	1.4
F Muskingum	7.8	4.3	1.8	4.5
G Kanawha - Little Kanawha	1.8	1.0	.1	.6
H Ohio - Huntington	1.1	.4	.1	1.6
I Scioto	10.2	8.3	7.0	9.4
J Guyandotte - Big Sandy Little Sandy	.5	.3	.0	.0
K Ohio - Cincinnati	1.7	1.0	1.5	1.0
L Little Miami - Miami	10.6	7.9	5.8	10.1
M Licking, Kentucky, Salt	1.5	.6	.1	.2
N Ohio - Louisville	1.4	.6	.9	.8
O Lower Ohio - Evansville	3.0	4.8	13.9	14.3
P Green	1.0	1.1	2.7	2.9
Q White	15.6	18.5	20.7	17.7
R Wabash	31.3	44.5	43.8	30.3
S Cumberland	2.5	1.9	.6	3.1
TOTAL	100.0	100.0	100.0	100.0

Source: 1949 and 1959 historical data based on The Census of Agriculture.

Appendix Table 6. Distribution of Feed Crop Production, Historical and Projected, Ohio River Basin, 1949-2010

Sub-Area	Tons of Product 1949	1959	1980	2010
	-------------	percent	-------------	
A Allegheny	1.5	1.3	.8	1.0
B Monongahela	.7	.3	.2	.3
C Pittsburgh SMSA	.7	.5	.2	.2
D Beaver	1.2	1.0	.5	.6
E Upper Ohio	1.0	.7	.3	.4
F Muskingum	4.8	4.5	3.5	5.2
G Kanawha - Little Kanawha	1.4	.5	1.0	.8
H Ohio - Huntington	1.2	1.0	.4	.4
I Scioto	7.7	8.5	11.0	13.3
J Guyandotte - Big Sandy Little Sandy	.4	.2	.2	.1
K Ohio - Cincinnati	2.0	1.9	1.0	.6
L Little Miami - Miami	10.0	10.7	14.2	15.3
M Licking, Kentucky, Salt	3.1	2.3	1.2	1.2
N Ohio - Louisville	1.5	1.3	.8	.3
O Lower Ohio - Evansville	5.5	5.3	3.2	.3
P Green	3.7	3.3	2.5	.6
Q White	15.8	17.6	16.2	15.9
R Wabash	32.1	35.0	39.8	42.4
S Cumberland	5.7	4.1	3.0	1.1
TOTAL	100.0	100.0	100.0	100.0

Source: 1949 and 1959 historical data based on The Census of Agriculture.

Appendix Table 7. Distribution of Crop Roughage Production, Historical and Projected, Ohio River Basin, 1949-2010*

Sub-Area	Tons of Product 1949	1959	1980	2010
	-----------percent----------			
A Allegheny	7.0	6.7	7.4	6.5
B Monongahela	3.8	3.3	1.9	4.4
C Pittsburgh SMSA	2.9	2.6	2.6	2.1
D Beaver	3.9	3.1	2.3	2.5
E Upper Ohio	4.1	3.2	2.6	3.7
F Muskingum	8.0	8.7	8.2	7.2
G Kanawha - Little Kanawha	5.5	5.3	3.7	6.6
H Ohio - Huntington	2.7	2.2	1.8	3.1
I Scioto	5.6	6.3	8.4	3.1
J Guyandotte - Big Sandy Little Sandy	.5	.3	.2	.9
K Ohio - Cincinnati	2.9	2.9	2.3	4.4
L Little Miami - Miami	6.9	7.4	10.4	3.1
M Licking, Kentucky, Salt	7.1	7.8	6.3	7.3
N Ohio - Louisville	2.7	2.4	3.2	2.6
O Lower Ohio - Evansville	3.7	3.4	2.8	4.9
P Green	5.3	4.7	3.9	6.0
Q White	8.1	9.5	11.1	9.9
R Wabash	10.7	13.2	15.0	13.6
S Cumberland	8.6	7.0	5.9	8.1
TOTAL	100.0	100.0	100.0	100.0

*Excludes roughage production on cropland pasture and native pasture.